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Roentgen Changes Associated with Pancreatic Insufficiency in Early Life[1]

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Pancreatic fibrosis is being recognized with increasing frequency and it is now known to be one of the important causes of death in infants and young children. In 1938, Blackfan and May (3) found 35 cases in 2,800 autopsies done in a period of fifteen years. In the same year Andersen (1) reported 49 cases, an incidence of 3 per cent, in her necropsy records. In the year 1942 the records of the Children's Hospital (Boston) showed that 12 per cent of the autopsied cases exhibited pancreatic fibrosis of a significant degree. Although there have been several excellent reviews (1, 5, 6) and numerous papers devoted to certain aspects of pancreatic insufficiency, the literature shows a decided paucity of description of the roentgenologic aspects. The moment seems opportune, therefore, for the presentation of our experience with over 50 patients who have manifested the changes of pancreatic fibrosis.

A brief review of the clinical and pathological findings is necessary for a proper understanding of the roentgenologic changes associated with this disease. Pancreatic fibrosis may be produced by a process limited to the pancreas and adjacent structures or it may be part of a generalized disease that is as yet incompletely understood, although the work of Farber and his associates and others have done much in furthering our knowledge of the subject.

Farber (7) has listed the following causes for a purely local process: Atresia or stenosis of pancreatic ducts; duct obstruction associated with certain forms of annular pancreas, and obstruction produced by calculi, neoplasms, and healed pancreatitis. In those instances where pancreatic fibrosis is but one manifestation of a widespread disturbance—and these constitute the majority of cases—there appears to be a failure of formation or a failure of liberation of pancreatic enzymes. Figure 1 shows the typical microscopic appearance, with dilatation of ducts, inspissation of secretion in atrophic acini, and connective tissue replacement and fibrosis. The result of this inspissation and obstruction is pancreatic achylia. Important changes are found in many other organs of the body. Glandular structures in the bronchi and trachea and in the intestinal tract may show marked alteration in the physical character of the secretions, with dilatation of ducts and inspissation of material. Intrahepatic biliary obstruction has been observed. Farber (7) has suggested the term "muco-viscidosis" for this generalized process.

[1] From the Department of Roentgenology of the Infants' and the Children's Hospital, 300 Longwood Ave., Boston, Mass. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

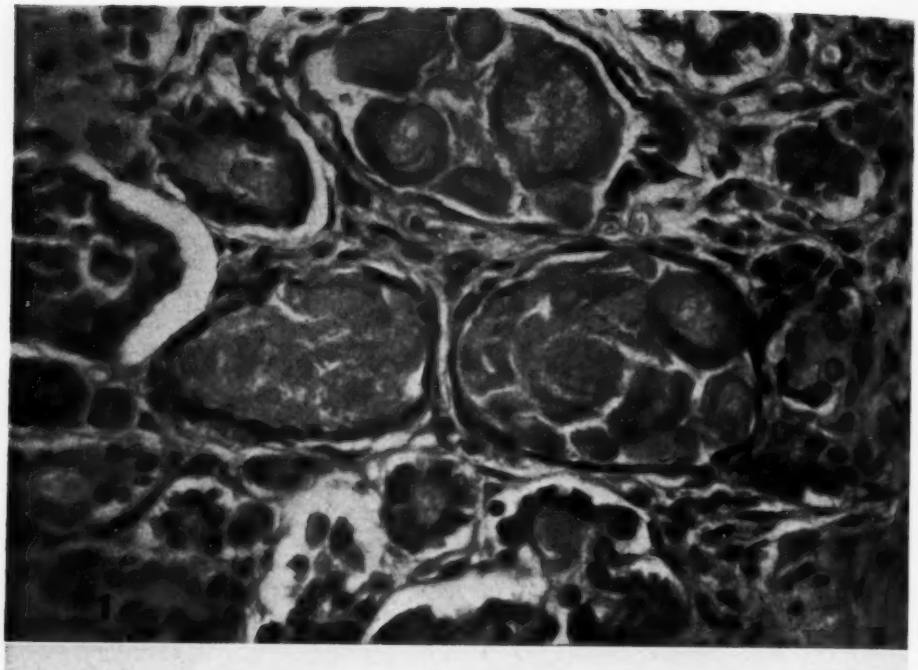

Fig. 1. Photomicrograph of section of pancreas. There is inspissation of secretion in dilated and atrophic acini. A moderate degree of fibrosis is evident.

Fig. 2. Meconium ileus. A segment of bowel cut open along the mesenteric border shows the character of the mucilaginous meconium that fills and obstructs the ileum and colon.

If achylia or marked reduction in the pancreatic enzyme activity occurs before birth, a conspicuous alteration in the physical quality of the meconium takes place in consequence of the absence of tryptic digestion. Figure 2 shows the sticky mucilaginous quality of the meconium that fills and obstructs the ileum and colon. The peristaltic activity of the bowel is insufficient to overcome the obstruction produced by this altered meconium, so that in the newborn infant meconium ileus results (11). If the pancreatic fibrosis is but part of a generalized disease process associated with this nutritional disturbance, there is almost invariably evidence of chronic pulmonary disease. The pulmonary disease in its early stages appears to be the result of bronchial obstruction of varying degree produced by thick, glairy, and tenacious secretions in the trachea, bronchi, and bronchioles (Fig. 3). A subacute or chronic staphylococcus bronchitis and bronchopneumonia is soon superimposed. Figure

Fig. 3. Posterior view of the opened trachea and major bronchi from an infant aged twenty months with pancreatic achylia. There is an abundance of thick, tenacious mucus which was obstructing the smaller bronchi and bronchioles. (Reproduced by permission of the A. M. A. Press, from Farber: Arch. Path. **37:** 238–250, 1944.)

(6). These patients are usually admitted to the hospital in the first week of life with signs and symptoms of intestinal obstruction.

When the effects of pancreatic hypochylia become manifest after birth, there results a chronic nutritional failure that is distinguished with difficulty from celiac disease. There are usually lack of subcutaneous fat and deficiency of muscle tissue particularly about the hips, buttocks, and shoulder girdle, a protuberant abdomen, and frequent attacks of diarrhea with foul and bulky stools with high nitrogen residue

4 shows the external aspect of the lungs as usually observed at autopsy. Marked irregular emphysema is evident, as are small areas of atelectasis. The cut surface of the lung (Fig. 5) will invariably show dilatation of the bronchi and bronchioles, with frequently some destruction of their walls. Peribronchial areas of pneumonia, frequent bronchiectatic abscesses, and areas of connective tissue replacement of lung parenchyma are observed. Clinically, either the chronic pulmonary disturbance or the nutritional failure may dominate the picture. If the pulmonary disease is evident,

Fig. 4. The lungs of a patient aged five years and seven months, with chronic nutritional failure. Pancreatic fibrosis was demonstrated at autopsy. There is marked emphysema with focal areas of atelectasis.

Fig. 5. Cut surface of a fixed lung from a patient aged ten months with pancreatic fibrosis and achylia. The lungs are overexpanded, many dilated bronchi are visible and there are widely scattered areas of consolidation with abscess formation. (Figs. 4 and 5 reproduced by permission of the A. M. A. Press, from Farber: Arch. Path. **37:** 238–250, 1944.)

the patients will exhibit a severe and usually non-productive cough, air hunger, and occasionally cyanosis. Physical findings may vary considerably.

The diagnosis can frequently be made from the clinical findings and symptoms or by the roentgenologic manifestations on examination of the lungs and the gastrointestinal tract. A low glucose tolerance or vitamin "A" curve will likewise suggest the diagnosis, but conclusive evidence of disease is shown by marked reduction or absence of pancreatic enzyme activity. Of the enzymes, trypsin deficiency seems to be most important. With faulty absorption of vitamin "A," a deficiency may result. Blackfan and Wolbach (4) and Farber (8) do not believe that this deficiency plays an important part in the clinicopathological picture of pancreatic fibrosis.

The roentgenological aspects of this disease are of considerable importance, as only too frequently the presence of the pancreatic fibrosis is not suspected until roentgen examination is made. In many instances an accurate x-ray diagnosis is possible. In our last 10 cases of meconium ileus the correct diagnosis was made in 4, while in the last 10 patients with pulmonary disease and nutritional failure the correct roentgen diagnosis was made in 8. Many investigators (9, 10) have mentioned the disturbance of motor function of the gastro-intestinal tract. Attwood and Sargent (2) have described in some detail the roentgen appearance of the lungs in the later stages of the disease. We know of no adequate description of the diagnostic features of meconium ileus. In approximately 60 per cent of patients with meconium ileus it has not been possible with our present knowledge to make a roentgen diagnosis other than that of small bowel obstruction, with rough localization of the obstruction. Figure 6 shows this type of picture. There is pronounced dilatation of small bowel loops with air and fluid levels when the film is made in the erect position. This appearance must differ only slightly from that produced by atresia or marked stenosis of the ileum. In other patients the films of the abdomen show a different appearance, and one that we feel is diagnostic (Fig. 7). There is no abrupt termination of the visualized gas and no terminal dilated loop of bowel to suggest a point of obstruction. It is apparent that a small quantity of gas has been forced into the tenacious mucilaginous meconium. Small and minute bubbles of gas can be seen scattered throughout the distal small

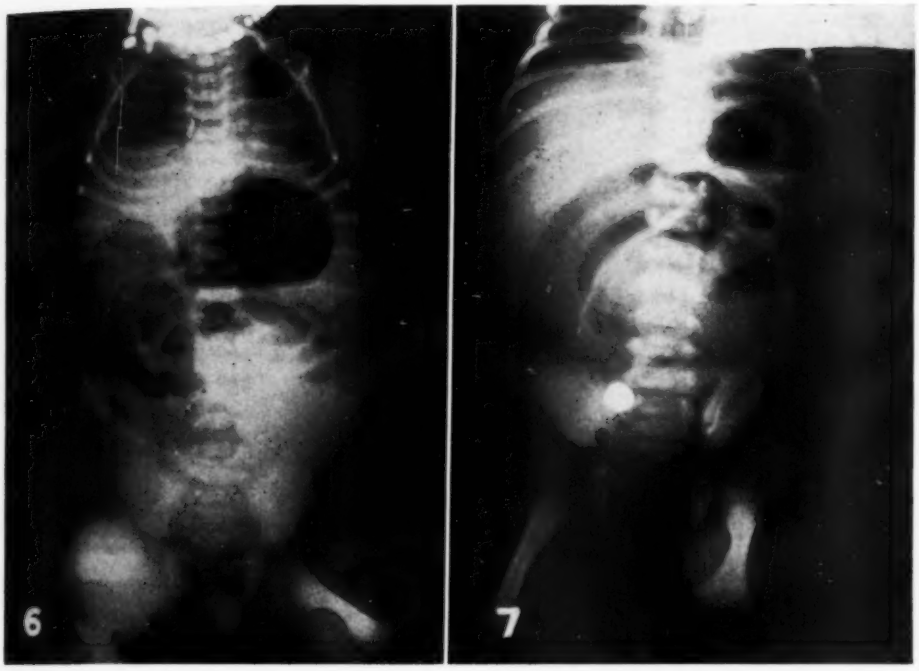

Fig. 6. Meconium ileus in a patient aged three days. There are many dilated loops of small bowel and no evidence of gas in the colon. The appearance is that of intestinal obstruction. The etiology is not evident.

Fig. 7. Meconium ileus in a patient aged two days. Intestinal obstruction with many minute bubbles of gas mixed with meconium suggests the diagnosis.

bowel, and here its caliber is somewhat smaller than that portion of the bowel which is well distended with gas. We have not observed this appearance in any other condition of the newborn. Examination by barium enema has not been attempted, as it was thought to be unwise in the presence of obvious necessity for immediate operation to relieve the obstruction.

Examination of the gastro-intestinal tract has been carried out in all but a few of the patients who showed evidence of the systemic disease associated with pancreatic fibrosis. We have found it difficult and frequently impossible to recognize a motor disturbance of the bowel in very young infants. It is well known that marked variation without known cause is to be expected in the gastric emptying time and the small bowel motility in young infants. Golden (9) states that before the age of one month, and frequently up to the age of three or four months, the normal small bowel pattern and motor activity of the gastro-intestinal tract are apparently identical with or very similar to that appearance exhibited by an older child with a deficiency state or nutritional disturbance. In older infants, when the adult type of pattern and activity is approached, the roentgen examination is helpful, but it must be emphasized that the changes are not specific for any single clinical entity but will usually lead to a diagnosis of a disturbance of the motor function of the bowel probably on a nutritional basis.

Examination before the administration of the barium meal will frequently show an excessive amount of gas in the small bowel, although admittedly this is difficult to estimate, as considerable gas is often normally present in the small bowel of infants and young children. If the examination

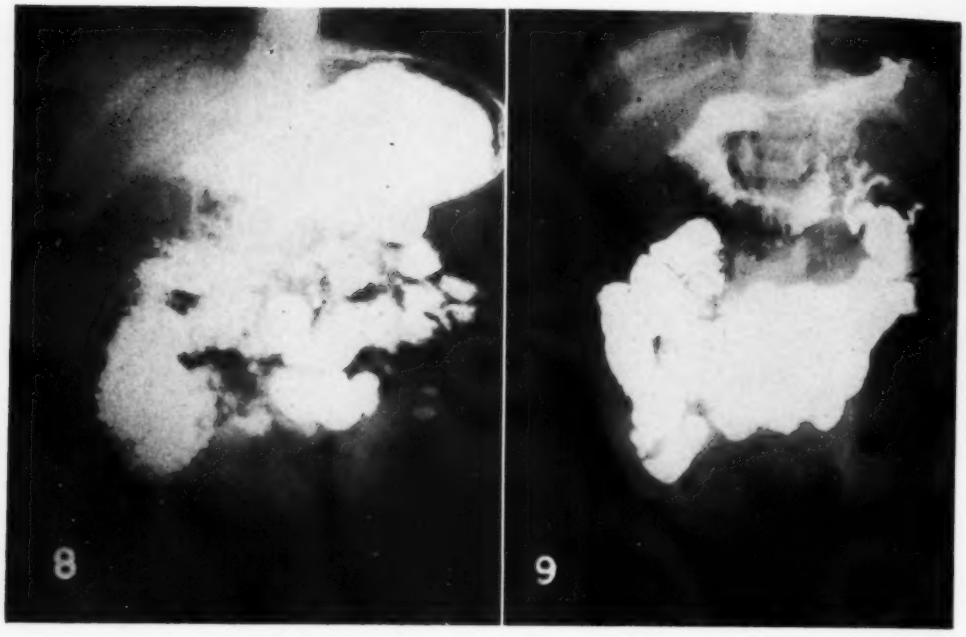

Fig. 8. Film of a patient aged three years and nine months who had pancreatic achylia and nutritional failure for three years and pulmonary disease for two years. There is disturbance of the small bowel pattern with alternating areas of hypertonicity and hypotonicity.

Fig. 9. Film of a patient aged three years and two months who had pancreatic achylia for nine months and pulmonary disease for fifteen months. The mucosal folds in the duodenum appear to be thickened and reduced in number and there is marked disturbance of the motor function of the bowel.

is carried out in the erect position, a few fluid levels may occasionally be observed, an appearance that we feel is compatible with partial ileus of loops of the small bowel. After the administration of barium, motility usually appears hyperactive if diarrhea is a prominent feature, but in the late stages of the disease motility is usually reduced even though a moderate degree of diarrhea may be present. The small bowel pattern shows considerable disturbance, with alternating areas of hypertonicity and segmental dilatation, so that the barium column is broken and exhibits clumping (Fig. 8). Even in the presence of hypomotility, segmental contractions are frequently prevalent and powerful. Only rarely (four cases) have we been able to recognize coarsening of the mucosal folds in the duodenum and jejunum, as observed by Golden in patients with nutritional disturbance. Figure 9 shows that the mucosal folds may be fewer in number and apparently thickened. The proximal intestinal tract in three patients has been examined by means of a small bowel enema, but no evidence of a gross morphological abnormality could be found, and in these three patients the mucosal folds did not appear to be unduly thickened. The disturbance of the motor function of the bowel can be temporarily corrected by administration of mecholyl (10).

Although the changes that have been described are not diagnostic of pancreatic fibrosis or any other entity, the importance of these changes must not be underestimated. Their demonstration warns of the necessity for further clinical and laboratory investigation. We have observed one patient with partial duodenal obstruction, pancreatic fibrosis, and chronic nutritional disturbance produced by an annular pancreas, and other similar cases have been found postmortem.

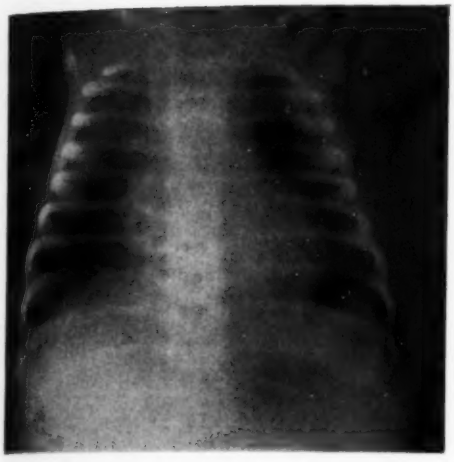

Fig. 10. Film of the chest of a patient aged four months who had cough and difficult respiration for two months. Autopsy showed pancreatic fibrosis and viscid mucus in trachea and bronchi with bronchial plugging.

Roentgen examination of the lungs frequently reveals changes that are quite characteristic. In accordance with the pathological findings we believe that it is possible to divide the pulmonary findings into two stages. The first (Figs. 10, 11) is that stage where there is evidence of varying degrees of bronchial plugging without any notable superimposed infection. Fluoroscopic examination is particularly helpful at this stage. The volume of the lungs is increased, with flattening and depression of the diaphragm. Many portions of the lung will show increased radiolucency. Widening of the intercostal spaces may be present, and there may be bulging of a few or many of the interspaces as seen at the periphery of the lung. There is the easily recognized picture of obstructive emphysema with poor air exchange. The lungs remain hyperexpanded in expiration. The emphysema is quite irregular; one or more areas of lobular or "plate" atelectasis can be recognized, and lobar collapse is frequent.

In the second stage, when infection has

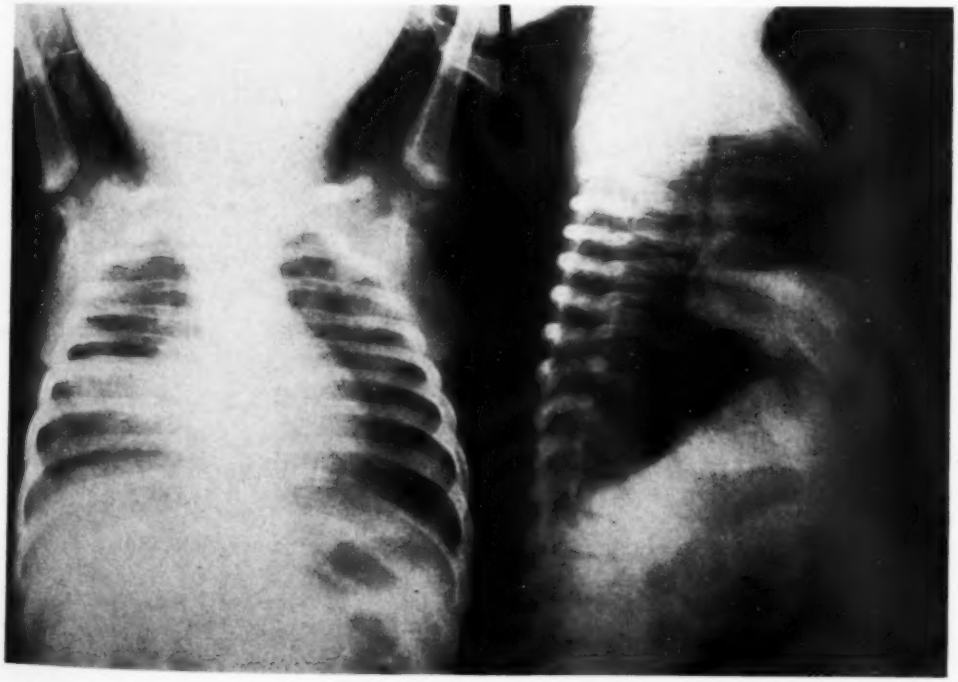

Fig. 11. Patient aged thirteen months who had cough and respiratory distress for three months. Note the collapse of the middle lobe and marked irregularity of aeration. Autopsy showed pancreatic fibrosis, marked bronchial plugging, and some early bronchitis and peribronchitis.

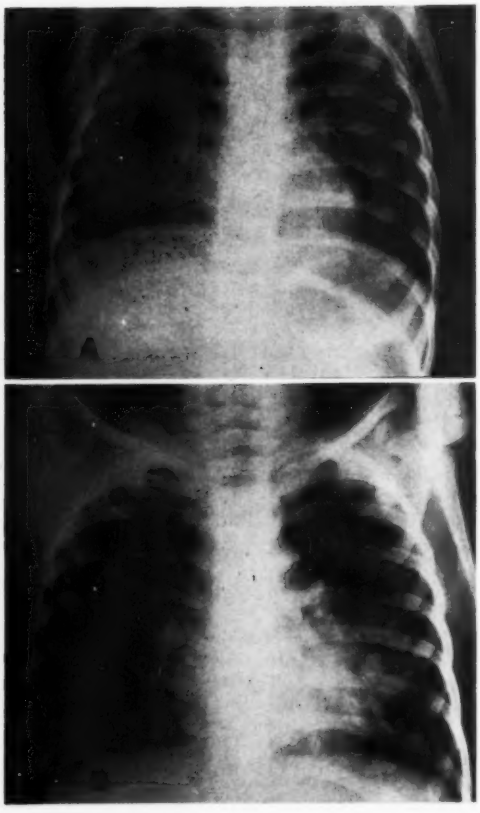

Fig. 12. A. Film of the chest of a patient aged fourteen months who had slight cough for one month, showing only slight irregularity of aeration. B. Six years later the chest showed far advanced changes. Note the irregular emphysema with extensive peribronchial infiltration. Probable duration of chronic staphylococcus pulmonary infection was about five years.

supervened, the roentgen appearance undergoes considerable change (Figs. 12–14). The hilar shadows are accentuated and there is symmetrical increase in the prominence of the bronchovascular markings. Occasionally thickened bronchial walls can be seen, and scattered throughout each lung are multiple areas of peribronchial increased density characteristic of peribronchial infiltration. Some of these areas may be confluent, giving the appearance of lobular pneumonia. Bronchiectasis is usually present, but we have found it difficult to recognize without lipiodol examination, and this we have not felt to be warranted. The end stage, in the patient with long-standing pulmonary disease, shows irregularly emphysematous lungs with prominent hilar shadows and bronchovascular markings, areas of atelectasis and extensive peribronchial pneumonia, bronchiectasis, and bronchiectatic abscesses. The changes are widespread, the apices and bases are equally involved, and the infiltration often extends to the periphery of the lung, although evidence of pleural reaction has not been observed on any of our films. It is to be assumed that this appearance is not pathognomonic, but the recognition of a long-standing pulmonary disease characterized by obstructive emphysema, atelectasis and fibrosis, and widespread infection, involving all lobes, is sufficient to warrant a tentative diagnosis of pancreatic fibrosis to be confirmed by examination of the enzyme activity of the duodenal juice.

Other changes of less importance may frequently be observed. The shadow of the liver is often enlarged. Examination of the long bones will occasionally show retardation of the bone age and osteoporosis or evidence of vitamin deficiency. It is hoped that, in the future, lipiodol bronchograms and other examinations, such as cholecystography, may yield useful information.

SUMMARY AND CONCLUSIONS

1. Pancreatic fibrosis is an important disease of early life and is being recognized with increasing frequency.

2. The clinical and pathological findings have been briefly discussed.

3. Meconium ileus is the result of pancreatic hypochylia or achylia occurring before birth. In 40 per cent of our recent cases the roentgen changes have been diagnostic.

4. When pancreatic fibrosis becomes manifest after birth, it may exist as a local process associated with a chronic nutritional failure closely resembling celiac disease and producing important changes in the motor function of the intestines.

5. In the great majority of cases, pancreatic fibrosis is part of a widespread proc-

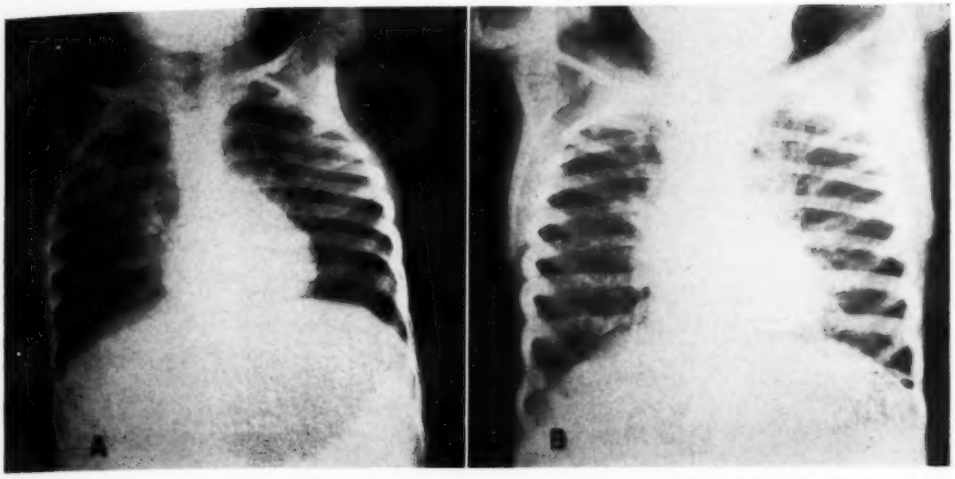

Fig. 13. A. Same patient as Figure 9. There is evidence of bronchial plugging with superimposed staphylococcus infection. B. Same patient ten months later. Note increase in emphysema and spread of peribronchial infection. Autopsy showed pancreatic fibrosis.

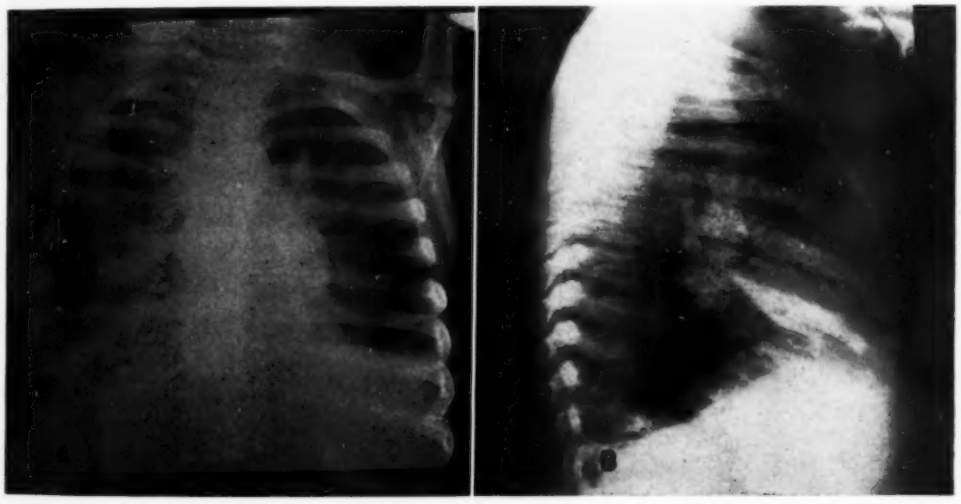

Fig. 14. A. Film of a patient aged eighteen months who had a cough and chronic nutritional disturbance for more than one year. Note emphysema and extensive infiltration. B. Lateral film shows collapse of the right middle lobe. Autopsy showed pancreatic fibrosis.

ess involving many of the glands of the body. Invariably associated with the nutritional disturbance in these patients is chronic severe bronchial obstruction with eventual superimposed staphylococcus infection. The roentgen changes in the later stages of the disease are readily recognized and in many cases are sufficiently characteristic to suggest the diagnosis.

6. Diagnosis of pancreatic fibrosis is confirmed by the demonstration of marked reduction or absence of pancreatic enzymes.

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REFERENCES

1. ANDERSEN, D. H.: Cystic Fibrosis of the Pancreas and Its Relation to Celiac Disease: Clinical and Pathologic Study. Am. J. Dis. Child. **55:** 344–399, 1938.

2. ATTWOOD, C. J., AND SARGENT, W. H.: Cystic Fibrosis of the Pancreas with Observations on the Roentgen Appearance of Associated Pulmonary Lesions. Radiology **39:** 417–425, 1942.

3. BLACKFAN, K. D., AND MAY, C. D.: Inspissation of Secretion, Dilatation of the Ducts and Acini, Atrophy and Fibrosis of the Pancreas in Infants: Clinical Note. J. Pediat. **13:** 627–634, 1938.

4. BLACKFAN, K. D., AND WOLBACH, S. B.: Vitamin A Deficiency in Infants: Clinical and Pathological Study. J. Pediat. **3:** 679–706, 1933.

5. FARBER, S.: Pancreatic Insufficiency and the Celiac Syndrome. New England J. Med. **229:** 653–657, 682–687, 1943.

6. FARBER, S.: Relation of Pancreatic Fibrosis to Meconium Ileus. J. Pediat. **24:** 387–392, 1944.

7. FARBER, S.: Personal communication.

8. FARBER, S.: Pancreatic Function and Disease in Early Life: Pathologic Changes Associated with Pancreatic Insufficiency in Early Life. Arch. Path. **37:** 238–250, 1944.

9. GOLDEN, R.: Abnormalities of the Small Intestine in Nutritional Disturbances: Some Observations on Their Physiologic Basis. Radiology **36:** 262–286, 1941.

10. MAY, C. D., AND MCCREARY, J. F.: Absorption of Vitamin A in Celiac Disease: Interpretation of Vitamin A Absorption Test. J. Pediat. **18:** 200–209, 1941.

11. SHOHL, A. T., MAY, C. D., AND SHWACHMAN, H.: Studies of Nitrogen and Fat Metabolism on Infants and Children with Pancreatic Fibrosis. J. Pediat. **23:** 267–279, 1943.

The Roentgen Diagnosis of Pancreatic Cyst[1]

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ALTHOUGH CYST of the pancreas is distinctly not a rarity, it cannot be classed among the common abdominal tumors. In a classical, comprehensive review of this subject in 1898, Korte (1) collected 121 cases from the medical literature. Judd *et al.* (2), in a more recent survey of the subject, state that out of more than 700,000 admissions to the Mayo Clinic between 1921 and 1931, only 88 patients were treated surgically for pancreatic cyst. Rabinovitch and Pines (3) reported 17 cases, in 14 of which operation was done. Virtually all other published articles regarding this entity have dealt with but one or a few patients. The relatively infrequent occurrence of pancreatic cyst is further emphasized by a review of the case records of the University Hospital (Ann Arbor), which reveals that, since July 1935, only 13 patients have received surgical treatment for this entity.

Because of this relatively low incidence of pancreatic cyst and the difficulties commonly encountered in its diagnosis, a brief analysis of pertinent findings which may facilitate that diagnosis seems warranted. Emphasis will be placed upon a particular combination of clinical and roentgenological signs occurring in conjunction with cysts arising in the tail of the pancreas. These signs have not been utilized to their fullest extent in the past, although frequently they are of great diagnostic value.

CLASSIFICATION

The classification of pancreatic cysts is at considerable variance. Suffice it to say that the majority of true cysts are either of the retention or the proliferative type. The former type is more common and is usually due to dilatation of a pancreatic duct. Korte (1) proposed the term pseudocyst for that type found in more or less close proximity to the pancreas, but apparently not arising in the gland substance, and existing without an epithelial lining. Apparently this type of lesion occurs more frequently than any of the true cysts; it usually arises near the tail of the pancreas.

CLINICAL FINDINGS

The symptoms of pancreatic cyst are not at all distinctive and may be closely simulated by numerous other intra-abdominal lesions. Certainly the most constant and important subjective complaint is pain, but it is so variable in location and extent that it has but little diagnostic value. Loss of weight, weakness, nausea, vomiting, and diarrhea are common but even less consistent symptoms. Jaundice may occur when a cyst grows large enough to obstruct the biliary duct system.

If the cyst is large enough to produce symptoms, a smoothly rounded mass usually may be palpated in the upper portion of the abdomen. This mass may appear suddenly, may slowly enlarge over an interval of months or years, or may fluctuate in both size and shape. The position and mobility of the mass are largely dependent upon the site of origin of the cyst, *i.e.*, the portion of the pancreas from which the cyst arises. When the lesion arises from the head of the pancreas, the presenting mass tends to be localized to the right upper quadrant or epigastrium. Under such circumstances the mass is fixed or only slightly movable. When, as is more frequently the case, the body or tail of the pancreas represents the site of origin of a cyst, the mass usually presents itself in the left upper quadrant and may be quite freely movable. Any of these cysts may

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Fig. 1. Retention cyst in tail of pancreas. Cyst clearly discernible by virtue of its own density in relation to density of surrounding soft tissues. Note slight displacement of stomach and upper jejunum.

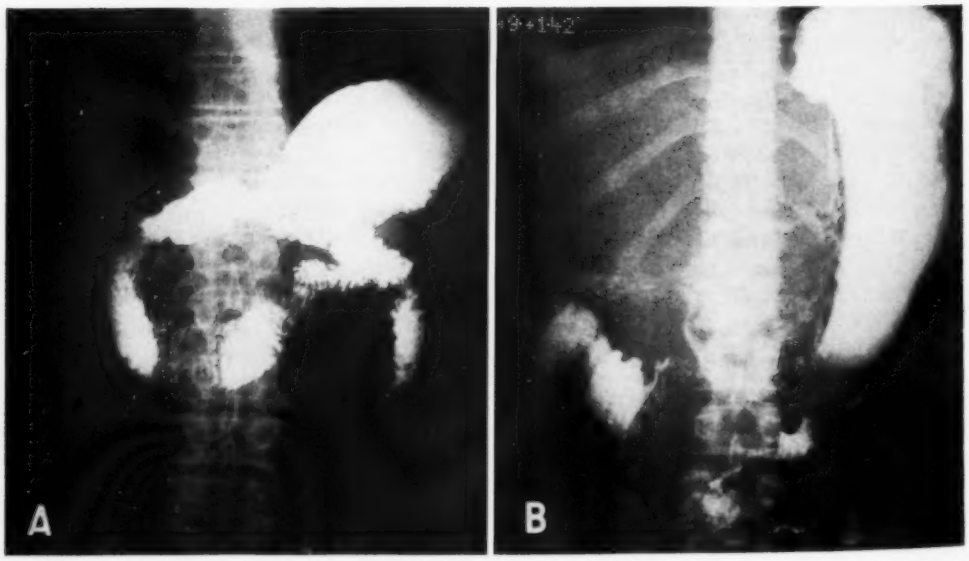

Fig. 2. A. Widening of duodenal loop and upward displacement of stomach due to retention cyst in head of pancreas. The stomach of a normal, hypersthenic person might well produce this same appearance.
B. Large cyst arising from mid-portion of pancreas. There is indentation and pronounced distortion of the lower end of the stomach and the duodenum.

become large enough to occupy the entire upper abdomen.

ROENTGEN FINDINGS

Complete examination of the gastrointestinal tract by roentgen methods is always indicated in patients with suspected pancreatic cyst. Much like the clinical signs of this lesion, the roentgen appearance varies according to the region of the pancreas from which the cyst arises and, furthermore, is considerably dependent upon the size of the cyst and its ultimate position in relation to the abdominal viscera. On occasion, the outline of a pancreatic cyst may be clearly visible in a roentgenogram of the abdomen (Fig. 1), but its presence is more frequently revealed by the extrinsic pressure defects it produces in the barium-filled stomach, proximal small bowel, and colon. Calcium deposits rarely outline the cyst wall.

As a rule, a cyst arising in the head of the pancreas produces widening of the duodenal loop with little or no deformity of the stomach (Fig. 2, A), whereas a cyst of the body of the pancreas displaces the stomach anteriorly and superiorly, with variable distortion of the proximal loops of small bowel. Occasionally, as Bruck (4) has illustrated, the cyst presents more superiorly and medially, resulting in a sweeping indentation of the lesser curvature (Fig. 2, B). None of these findings is particularly diagnostic of cyst to the exclusion of neoplasm.

Concerning a cyst arising from the tail of the pancreas, Case (5) and others have pointed out that such a lesion very frequently produces a smoothly rounded indentation in the greater curvature of the stomach at or just above its mid-portion (Figs. 3, 4, and 5). A lateral view shows a more generalized indentation of the posterior gastric wall with associated anterior displacement of the entire stomach (Fig. 4). The duodenal-jejunal flexure is displaced downward and the splenic flexure of the colon either may be indented along its medial aspect or displaced caudally.

The greater curvature indentation may

Fig. 3. Retention cyst in tail of pancreas producing smoothly marginated indentation of greater curvature of stomach. Cardiac and prepyloric regions appear normal. Observe concentric compression of gastric rugae.

show postural variations, but usually is best demonstrated with the patient in a prone, right anterior oblique position. Although the defect is not demonstrable in all patients having a cyst arising from the tail of the pancreas, it occurs often enough to warrant more emphasis than it has been accorded in the past. Of the 13 patients treated surgically for pancreatic cyst in this hospital, 7 had a cyst arising in the tail of the pancreas. Five of these 7 patients showed the greater curvature deformity just described.

DIFFERENTIAL DIAGNOSIS

Conceivably, an enlarged spleen, splenic cyst, mesenteric cyst, omental cyst, or retroperitoneal neoplasm might very well produce a similar localized indentation of the mid-portion of the greater gastric curvature, but such has not been our experience. In an exhaustive search of the University Hospital files, the only recognized

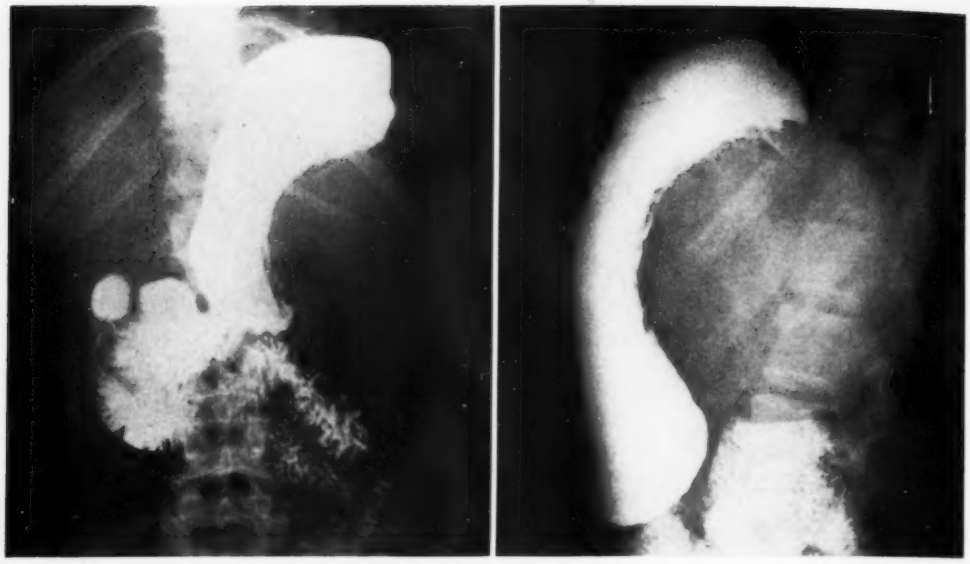

Fig. 4. Characteristic indentation of greater gastric curvature by retention cyst arising in tail of pancreas. Lateral view shows anterior indentation and displacement of stomach. Note downward displacement of duodenal-jejunal flexure.

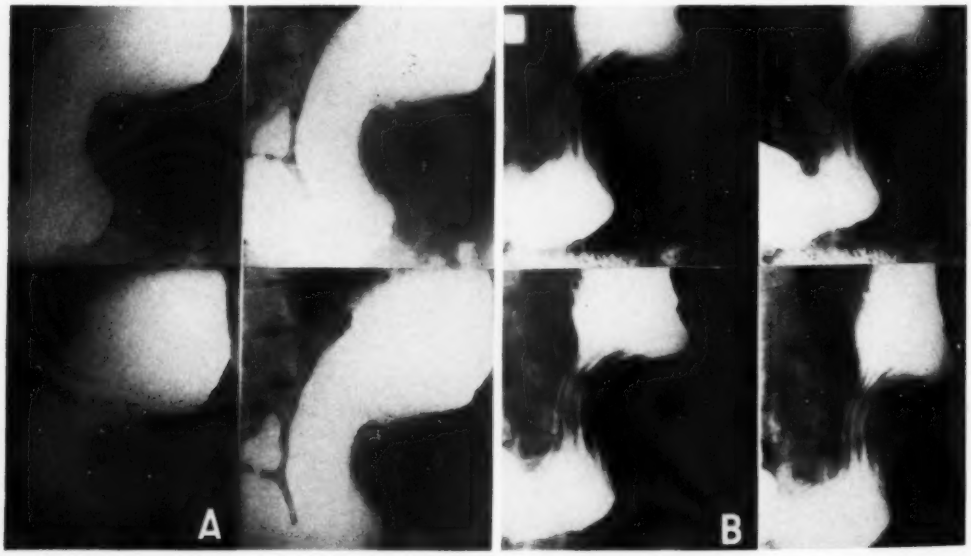

Fig. 5. A. Serial set showing deformity produced by cyst adherent to tail of pancreas. Histological examination of the excised specimen showed it to contain remnants of the wolffian body.

B. Another retention cyst arising in tail of pancreas and producing pronounced greater curvature indentation. Note similarity to Figures 3, 4, and 5, A.

extra-alimentary masses which simulated the greater curvature deformity, and at the same time produced anterior displacement of the stomach, were a congenital cyst of wolffian body origin (Fig. 5, A) and a neoplasm arising from the lower pole of the left kidney. Incidentally, the wolffian body cyst was described in the surgeons' operative note as a cyst arising from the tail of the pancreas, and it was not until histological examination of the specimen was done that the true nature of the lesion was ascertained. Pyelography readily identified the renal lesion.

SUMMARY

The importance of anterior displacement of the stomach and smoothly rounded indentation relatively high on the greater gastric curvature as a combination of roentgen signs suggestive of cyst in the tail of the pancreas should be clearly appreciated. This is especially true when such deformity is encountered in conjunction with a rounded, ballotable, freely movable mass in the left upper quadrant of the abdomen. Under such circumstances, the roentgenologist not only can make a diagnosis of pancreatic cyst with reasonable assurance of being correct, but he can be of further assistance to the surgeon by suggesting the exact site of origin of the lesion.

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BIBLIOGRAPHY

1. KORTE, W.: Die chirurgischen Krankheiten und die Verletzungen des Pankreas, Deutsche Chir., Stuttgart, Ferdinand Enke, 1898, p. 234.

2. JUDD, E. S., MATTSON, H., AND MAHORNER, H. R.: Pancreatic Cysts.: Report of 47 Cases. Arch. Surg. **22:** 838–849, May 1931.

3. RABINOVITCH, J., AND PINES, B.: Cysts of the Pancreas. Arch. Surg. **45:** 727–746, November 1942.

4. BRUCK, S.: Pancreatic Cysts. Radiology **25:** 303–307, September 1935.

5. CASE, J. T.: Roentgenology of Pancreatic Disease. Am. J. Roentgenol. **44:** 485–518, October 1940.

Congenital Duodenal Obstruction

Report of Six Cases and Review of the Literature[1]

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CONGENITAL obstruction of the duodenum, first described by Calder (7) in 1733, was long considered a fatal malformation of the newborn and a subject merely of academic interest. In view of the rapid downhill course within a week or two after birth, the diagnosis was formerly made by the pathologist at the necropsy table. More recently, however, the condition has been recognized clinically and roentgenologically, and during the past decade surgical procedures have been carried out successfully (2, 5, 11, 12, 13, 18, 19, 24, 25, 31, 38, 40, 43, 46, 48, 49).

So far about three hundred cases have been recorded in the literature (32). Approximately fifty patients have been operated upon, one-half of whom survived. Due to improved methods, introduced by Ladd (29), Donovan (10), and their coworkers, the mortality rate has been still further reduced. In spite of these advances, however, the disorder has received but little attention in the roentgen literature (20, 26, 35, 44, 45).

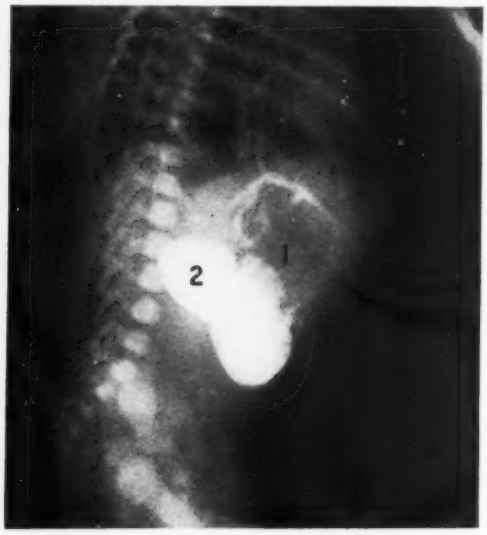

Fig. 1. Case 2. Duodenal atresia at ampulla. Moderate dilatation of stomach (1) and marked distention of proximal portion of duodenum (2). No evidence of gas or barium in the intestine.

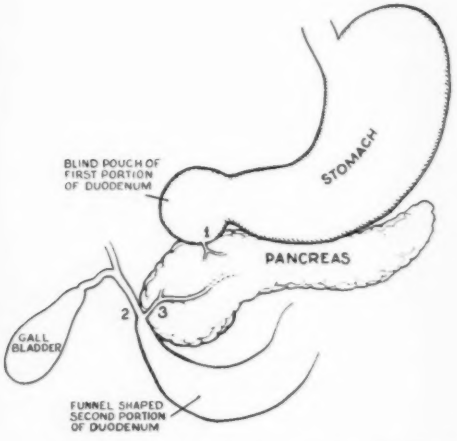

Fig. 2. Case 2. Diagram of autopsy findings of duodenal atresia with anomalies of pancreatic and bile ducts. 1. Duct of Santorini leading into the first portion of the duodenum. 2. Common bile duct entering at the narrow apex of the second portion of the duodenum. 3. Separate opening of the duct of Wirsung near the orifice of the common duct.

In this communication we shall report six cases of congenital duodenal obstruction and summarize the salient features from the literature.

REPORT OF CASES

CASE 1: *Atresia of First Portion of the Duodenum* (French Hospital, Service of Dr. F. C. Holden). A newborn white male vomited persistently after each feeding, at first food, later blood-tinged and

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finally coffee-ground material. The stools contained only meconium. The patient died on the third day of life, having had no roentgen examination.

At autopsy, the stomach and first portion of the duodenum were found to be greatly dilated, the latter forming a blind pouch. There were numerous submucosal hemorrhages. The second portion of the duodenum was completely separated and contained at its funnel-shaped apex the orifice of the common bile duct. The head of the pancreas was closely attached to this region. There was no abnormality of the gallbladder or extrahepatic bile ducts. The pathological diagnosis was congenital atresia of the first portion of the duodenum.

CASE 2: *Duodenal Atresia at Ampulla with Anomalies of Pancreatic and Common Bile Ducts. Non-Rotation of Intestine* (French Hospital, Service of Dr. F. C. Holden). A newborn white male vomited shortly after the first feeding and continuously thereafter. The stools contained only meconium. A roentgen study revealed a moderate dilatation of the stomach and proximal portion of the duodenum; no barium passed into the jejunum. The intestine contained no gas (Fig. 1). A diagnosis of congenital duodenal atresia was made, but when a laparotomy was performed, on the ninth day, only a non-rotation of the intestine was found. Death occurred five days later.

At autopsy, the stomach appeared moderately dilated. The first portion of the duodenum formed a blind pouch with a small bulge through which the duct of Santorini emptied. The second portion of the duodenum was funnel-shaped, the common duct entering at its narrow apex. Near the orifice of the bile duct a separate opening of the duct of Wirsung was found (Fig. 2). There were no traces of intestinal structure between the two portions of the duodenum. No further anomalies of the abdominal organs were noted. The pathological diagnosis was congenital duodenal atresia at the ampulla with anomalies of the pancreatic and common bile ducts.

CASE 3: *Subtotal Duodenal Stenosis at Ampulla* (New York Hospital, Service of Dr. S. Z. Levine). A newborn white female began to vomit shortly after the first feeding and had to be fed parenterally. Normal stools were passed. A roentgenogram of the abdomen on the fourth day revealed a gas pocket in the gastric area which apparently outlined the partly deflated stomach. To the right of the mid-line was a larger gas pocket which was believed to represent the grossly distended proximal portion of the duodenum. No gas was seen in the small and large bowel (Fig. 3). The infant showed progressive signs of emaciation and dehydration and died on the sixteenth day.

Autopsy revealed an almost complete duodenal obstruction at the ampulla of Vater. The prestenotic portion of the duodenum and the stomach were greatly distended. The second portion of the duodenum was narrowed down to only 1 mm. in width, and a thin probe could be passed for a distance of 3 mm. into the third portion. The pathological diagnosis was subtotal congenital duodenal stenosis at the ampulla.

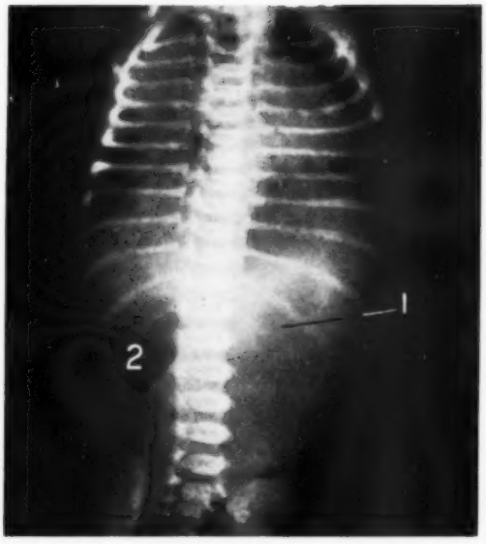
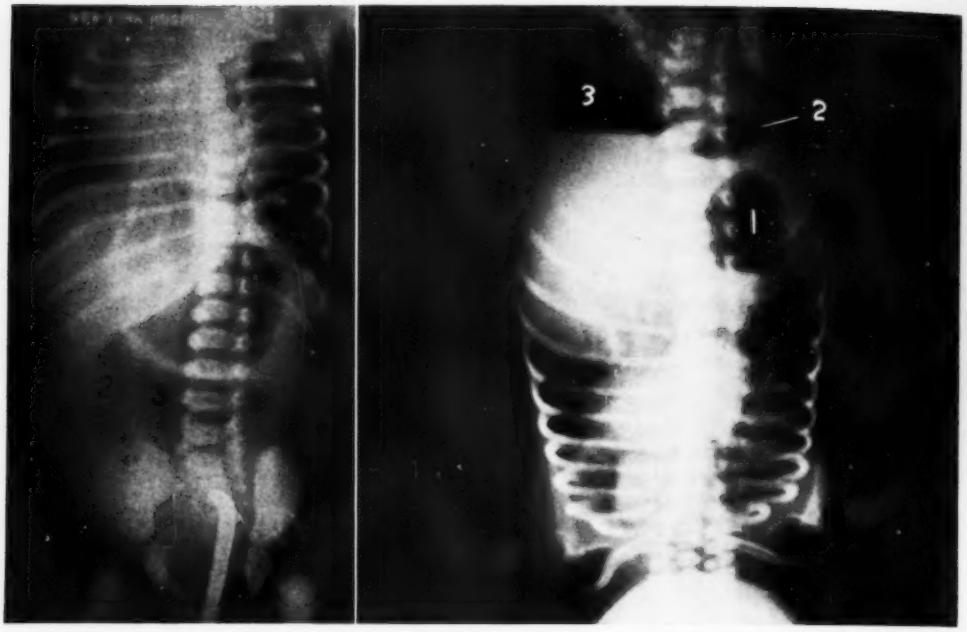


Fig. 3. Case 3. Subtotal duodenal stenosis at ampulla. 1. Small gas pocket in the gastric area, apparently outlining the partly deflated stomach. 2. Large gas pocket in distended proximal portion of the duodenum. Absence of intestinal gas pattern.

CASE 4: *Atresia of the Duodenojejunal Flexure* (New York Hospital, Service of Dr. S. Z. Levine). A newborn white female began to vomit bile-stained material after each feeding. The upper part of the abdomen was markedly distended, and the stomach was well demarcated. The liver and the spleen were not palpable. A supine view of the abdomen revealed three gas pockets in the upper and middle abdomen and absence of gas in the small and large intestine. The gas pockets were believed to represent the stomach and the distended duodenum (Fig. 4). In the inverted position the larger duodenal pocket had shifted from the mid-line to the right lower abdomen and showed a large amount of fluid. The other two gas pockets in the gastroduodenal area had become partly deflated, containing only small fluid levels (Fig. 5). A cord-like mass of feces was removed by enema. It consisted of meconium and was negative for bile. With the clinical and roentgen diagnosis of upper intestinal atresia, a laparotomy was performed. The infant died two hours after the operation.

At autopsy, a complete blind ending of the third portion of the duodenum was found 6 cm. distal to the pylorus. The proximal end of the jejunum was closed and completely detached from the duodenum.



Figs. 4 and 5. Case 4. Atresia of duodenojejunal flexure. Figure 4 (left) shows three gas pockets in the upper abdomen, believed to outline the stomach (1), first (2), and second and third (3) portions of the duodenum. Absence of intestinal gas pattern. Figure 5 (right), in the inverted or upside-down position, shows gas pockets in the stomach (1) and proximal duodenum (2) partly deflated, having small fluid levels. A large gas pocket in the distal duodenum (3), shifted to the right lower abdomen, shows a large fluid level.

The intestinal tract was collapsed and contained inspissated pale material. The pathological diagnosis was congenital atresia of the duodenojejunal flexure.

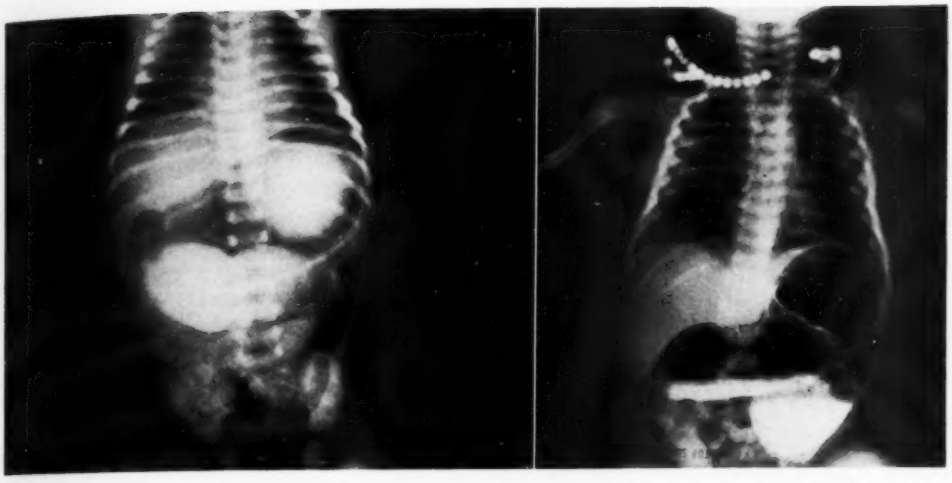
CASE 5: *Atresia of the Duodenojejunal Flexure* (City Hospital, Service of Dr. C. S. Boyd). A newborn colored male, seen in 1928, failed to retain liquids after each feeding and vomited persistently. The downhill course was so rapid that he died on the fifth day of life.

At autopsy, the duodenum was grossly distended and appeared larger than the stomach, which was also dilated. There was a collapse of the small and large intestine. A veil-like sheet of mucosa completely obstructed the lumen of the third portion of the duodenum slightly beyond the ligament of Treitz. The pathological diagnosis was congenital atresia of the duodenojejunal flexure.

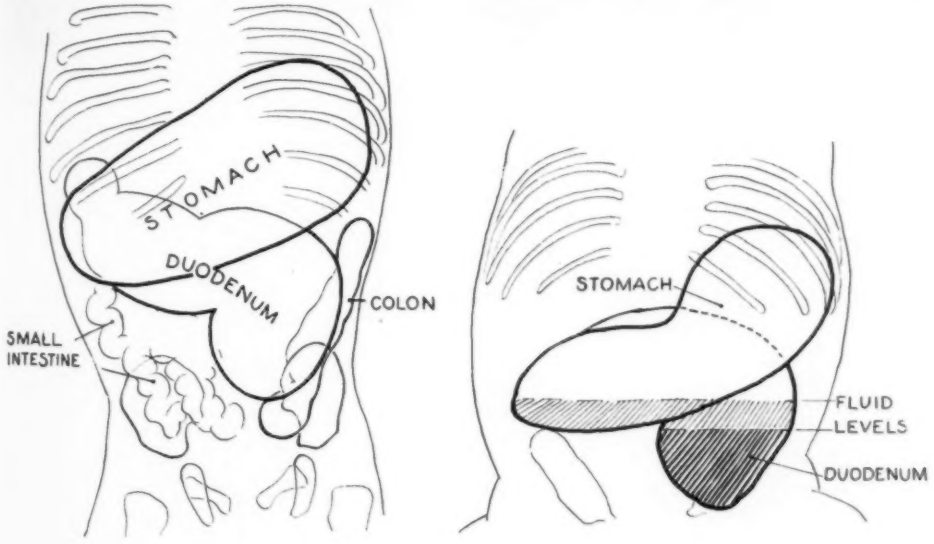
CASE 6: *Subtotal Stenosis of the Duodenojejunal Flexure with Mucosal Partition. Non-Rotation of Intestine* (City Hospital, Service of Dr. G. R. Irving). A newborn colored female had an uneventful course until the third day of life, when vomiting began, becoming progressively worse thereafter. There was regurgitation of yellowish-green material, which on one occasion was blood-stained. One to two soft brownish-green stools were passed daily. The infant had a weight loss of a full pound within a week; it became dehydrated and drowsy. The abdomen was soft, no masses being palpable, and peristaltic waves were not visible.

An oral barium study on the sixth day revealed marked dilatation of the stomach. Of special interest was a gross distention of the duodenum which extended from the right flank to the left of the mid-line and curved downward toward the pelvis. The duodenum appeared even larger than the dilated stomach (Fig. 6). Only small amounts of gas were present in the small intestine and colon. In the erect view barium levels were seen in the dilated stomach and in the grossly distended third portion of the duodenum (Fig. 7). In the oblique view the stomach and duodenum presented an hourglass appearance, the intervening constriction being apparently formed by the pylorus (Fig. 8).

At operation on the same day adhesions were found between the distal third of the stomach and the jejunum. When these were freed and the stomach was rotated cephalad, a vascularized band was seen to extend from the pyloric region to the transverse colon. This was severed, and material subsequently passed into the small intestine. The abdomen was closed without drainage. Vomiting diminished, but on the second postoperative day, it again became severe. A second operation, three days later, revealed dilatation of the stomach and the small intestine. The cecum and ascending colon



Figs. 6 and 7. Case 6. Subtotal stenosis of duodenojejunal flexure. Figure 6 (left) shows dilatation of the stomach and gross distention of the duodenum. Only small amounts of gas are seen in the intestinal tract. Figure 7, an erect view, illustrates the fluid levels in the dilated stomach and grossly distended duodenum.



Figs. 6A and 7A. Diagrammatic illustration of findings shown in Figures 6 and 7.

were found on the left side of the abdomen. Pressure on the stomach caused gas to pass into the jejunum.

The infant improved for a few days, but vomiting recurred and the stools began to contain blood. Finally, a general peritonitis developed, and death occurred on the twentieth day of life.

At autopsy, the stomach and duodenum were found to be greatly distended. At the duodenojejunal flexure was a ring-like constriction due to a white band of the serosa. On opening the intestine, the point of constriction corresponded to a partition with an eccentric slit-like opening, measuring 3 mm. in length. The pathological diagnosis was subtotal congenital stenosis of the duodenojejunal flexure with mucosal partition and a slit-like opening and non-rotation of the intestine.

DISCUSSION

Congenital obstruction of the duodenum occurs as atresia (19) or stenosis. Atresia

Fig. 8. Case 6. Oblique view showing hourglass appearance of dilated stomach and grossly distended duodenum.

represents a complete closure of the lumen and may vary from a thin diaphragm (28) to complete absence of a segment of the organ, also called aplasia (33). Stenosis represents a narrowing of the lumen, which may vary from one of high degree, subtotal, to partial narrowing of less extent. Atresia and subtotal stenosis are incompatible with life unless surgical repair is carried out within the first week. Partial stenosis, however, has occasionally been observed both in children and adults without seriously interfering with normal life (17, 47, 50). Atresia has been found twice as often as subtotal and partial stenosis, apparently due to the seriousness of the former, while the latter may remain undiscovered (6, 14, 15). This proportion is maintained in our series of four atresias and two subtotal stenoses.

The obstruction may occur in any part of the duodenum, but the sites of predilection are the middle and lower portions. According to Cordes (8) and Spriggs (39), about one-third of the obstructions are found close to the ampulla of Vater and one-third at the duodenojejunal junction. Of the total obstructions, barely one-third involve the preampullary segment. In our series three were at the duodenojejunal flexure, two at the ampulla, and only one at the first portion of the duodenum.

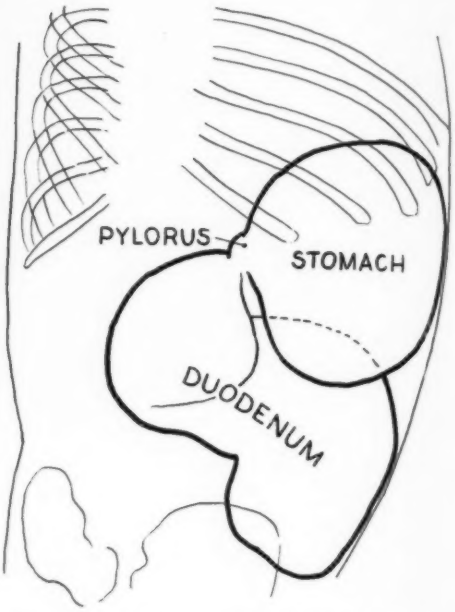


Fig. 8A. Diagram of findings shown in Figure 8.

The types of obstruction have been classified in many ways (4, 36, 42). For purposes of simplification they can be narrowed to four forms (Fig. 9):

1. Diaphragm with or without perforation, the most frequent type (Cases 5 and 6).
2. Filiform lumen (Case 3).
3. Blind ends connected by a fibrous cord.
4. Blind ends without any connection (Cases 1, 2, and 4).

No predilection for sex or race has been found, but a familial occurrence has been observed by Brodsky (3).

The disorder is the result of the persistence of conditions normal for some period of fetal development and occurs at the

site of embryologic events. A clear understanding is due largely to the work of Tandler (41), Forssner (16), Bland Sutton (1), Cordes (8), and others (27).

Between the fifth and twelfth week of gestation, the lumen of the fetal duodenum becomes completely obliterated by epithelial proliferation and changes into a solid cord. At the same period the pancreatic and hepatic ducts are being formed. Should the lumen fail to become patent again, stenosis or obstruction results, dependent upon the degree of normal development.

Extrinsic duodenal factors sometimes play a role during fetal life in the development of obstruction. The persistence of an hepatoduodenocolic ligament, after the rotation of the stomach and duodenum, has been reported as one cause preventing the re-establishment of the duodenal lumen (22). Other causes have been dermoid cysts, mesenteric cysts, annular pancreas, pancreatic tumors and cysts, internal herniae (34), peritoneal adhesions (17), massive volvulus of the bowel (37), failure of mesocolic fixation from arteriomesenteric obstruction or axial rotation of the mesentery, abnormally short or long mesentery, faulty rotation of the midgut, anomalies of the superior mesenteric artery and vein, and excessive development of the anlage of the intestinal villi.

In our Case 6, two factors appeared to play a part; one extrinsic, a band, and the other intrinsic, failure to recanalize. The band may have been the deciding factor. Associated incomplete rotation of the bowel has frequently been described, as in our Cases 2 and 6.

CLINICAL FINDINGS

The clinical findings are those of high intestinal obstruction and vary somewhat depending upon the degree of occlusion and the site of the lesion. In atresia and subtotal stenosis, vomiting begins soon after birth; it may occur from several minutes to two hours after food intake and recurs after each feeding. With a prevaterian lesion, the vomitus consists of ingested food and mucus, and after repeated attacks it may become blood-tinged. Bile is absent with complete obstruction unless abnormal bile ducts empty into the first portion of the duodenum. The stools contain mucus and bile. In the postvaterian type, the vomitus consists of ingested food and bile, often

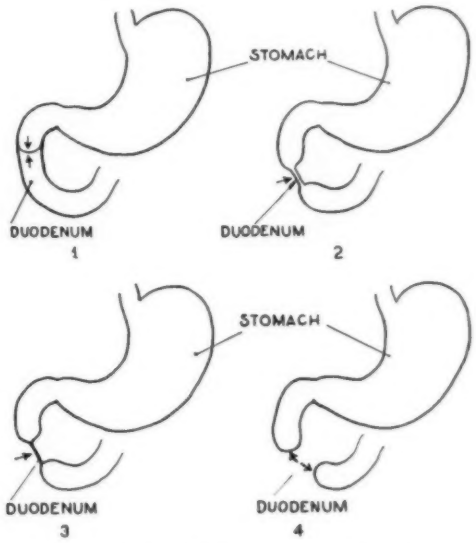


Fig. 9. Four types of congenital duodenal obstruction: 1. Diaphragm (arrows) with or without perforation, most frequent type (Cases 5 and 6). 2. Filiform lumen (arrow) (Case 3). 3. Blind ends connected by fibrous cord (arrow). 4. Blind ends without connection (arrows) (aplasia) (Cases 1, 2, and 4).

mixed with albumin, hematin, and fat. The stools are usually gray, of pasty consistency, and contain mucus. In subtotal stenosis keratinized epithelium, lanugo hair, milk curds, and bile may be found in the meconium. Bowel movements are usually scanty in either type, and loss of weight and dehydration tend to be rapidly progressive.

Inspection reveals a distended epigastrium and sometimes a sunken hypogastrium (23). A soft palpable mass corresponding to the distended duodenum may be present in the right upper quadrant. The distention of the duodenum may be so great as to extend far to the right and to the hypogastrium. Peristalsis of the stomach and the duodenum is frequently visible. In greater degrees of duodenal disten-

tion the waves may be seen running obliquely from right to left. After vomiting spells, the appearance can change to such an extent that the abdominal distention may disappear completely.

The clinical findings with lesser degrees of obstruction are quite different from those of atresia and subtotal stenosis. Vomiting may be delayed for a period of weeks after birth and may occur intermittently as a result of transient volvulus or blocking of the narrow lumen by undigested food.

ROENTGEN DIAGNOSIS

As soon as symptoms and signs suggest duodenal obstruction, a roentgen examination is indicated for confirmation of the clinical impression. Detailed information may then be gained as to the degree of obstruction and the approximate location of the lesion.

Routine abdominal films, taken in various positions, will show gas distention of stomach and duodenum and fluid levels in the erect posture. In atresia there is absence of gas beyond the duodenum (Figs. 1, 3, 4, and 5), but when the obstruction is incomplete, small amounts of gas are usually present in the intestine (Figs. 6, 7, and 8). Films taken with the infant in the inverted position will show fluid levels in the lower abdomen, and the overlying gas shadows may extend downward to the pelvic area (Fig. 5).

If definite conclusions cannot be made from ordinary films, a barium study is warranted for additional information. In spite of the use of a thin solution, the danger of clogging of a stenosed lumen by inspissated barium must be kept in mind. It may be safer to inject only a minimal amount through a duodenal tube and to aspirate the contrast material afterward. The obstruction cannot always be accurately localized when the stomach and duodenum are grossly distended, rotated, and overlap each other. The stomach and the pre-obstructed portion of the duodenum may yield an hourglass appearance (Fig. 8) and thereby the erroneous impression of a so-called bilocular stomach. The hourglass appearance, however, is pathognomonic of duodenal obstruction. It is due to contraction of the pyloric ring and denotes an extreme distention of the upper duodenal segment. The latter extends usually far to the right and, when the obstruction is at the ampulla or the duodenojejunal junction, turns downward to the left again, the blind end forming a culde-sac (Figs. 6, 7, and 8).

Gastroduodenal peristalsis is usually poor, due to an early exhaustion of the over-distended organs, and has been observed only a few times.

A diagnosis of atresia can be made when barium fails to pass beyond the duodenum within six hours and when the intestinal gas pattern is missing. If the obstruction is incomplete, some barium and gas can always be seen in the intestine on the six-hour film. In incomplete obstruction, follow-up studies at twenty-four and forty-eight hours and a barium enema may be advisable to exclude additional stenotic lesions and other congenital changes of the intestine.

DIFFERENTIAL DIAGNOSIS

Obstruction of the jejunum and ileum may be differentiated from duodenal occlusion by a delay of vomiting after the feeding. Pyloric stenosis differs in that it does not become apparent immediately after birth, but, at the earliest, three weeks later. In this condition a pyloric tumor may be palpated, while it is absent in duodenal obstruction. Vomiting associated with an esophageal pouch occurs during or immediately after the feeding but causes no disturbance of intestinal digestion. When vomiting is due to cerebral lesions, acetonemia, or toxic stages of an infectious process, roentgen studies will be helpful in excluding duodenal obstruction.

From a roentgenologic standpoint, the differential diagnosis between obstruction of the small intestine, observed in 15 per cent of cases of congenital intestinal obstruction, and of the third duodenal portion has to be considered. In jejunal and ileal obstruction a dilatation of the

duodenum due to stagnation and retrograde movements may become quite pronounced, thereby simulating duodenal stenosis.

In the European literature, Huber (21) reported cases with clinical manifestations of transient and recurring duodenal obstruction. In the surviving children, however, roentgen findings were normal, and in a few cases which came to autopsy hypoplasia of the mesenteric plexus was found without narrowing of the intestinal lumen. These findings suggested a disturbance of the sympathetic and parasympathetic innervation and possibly achalasia.

PROGNOSIS AND THERAPY

Partial stenosis offers a distinctly favorable prognosis. The fact that this condition is rarely seen suggests that it may frequently remain undiscovered, especially when overshadowed by other congenital abnormalities of the intestine. Subtotal stenosis is far more serious, and infants rarely survive more than three weeks unless the continuity of the intestinal tract is re-established by surgical measures. Atresia is incompatible with life, and an emergency operation is necessary within the first week. The downhill course is rapid, and dehydration may have progressed so far as to make surgical intervention useless.

The operations employed are duodeno-duodenostomy, duodeno-jejunostomy, and posterior gastro-enterostomy, varying with the site of obstruction. In malrotation of the intestine a repair of the mesentery may become necessary. Success of the operation depends, in part, on the presence or absence of additional malformations. Multiple obstructions have been observed (9) and must be carefully searched for at the time of the operation. The patency of the small intestine may be checked by passing a metal-tipped tube, as suggested by Maris (30).

Most essential for a favorable outcome is a close co-operation between obstetrician, pediatrician, roentgenologist, and surgeon. The obstruction may be recognized roentgenologically but later be missed at operation, when co-existent volvulus or incomplete rotation of the bowel obscures the surgical field.

SUMMARY AND CONCLUSIONS

1. Congenital obstruction of the duodenum in its complete form is incompatible with life.

2. Since the downhill course is rapid, the survival depends on a correct roentgen diagnosis and an emergency operation within the first week of life.

3. The characteristic roentgen findings of atresia and subtotal stenosis are dilatation of the stomach and gross distention of the duodenum, sometimes with hourglass appearance, complete six-hour residue, and lack of intestinal pattern.

4. When the surgeon succeeds in establishing continuity of the intestine and in excluding coexistent malformations elsewhere, the prognosis is favorable.

5. Four cases of atresia and two cases of subtotal stenosis are reported. The essential clinical and pathological features are discussed. The literature is reviewed.

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REFERENCES

1. BLAND SUTTON, J.: Imperforate Ileum. Am. J. M. Sc. **98:** 457–462, 1889.
2. BOLLING, R. W.: Complete Congenital Obstruction of the Duodenum, Duodeno-Jejunostomy at Nine Days. Ann. Surg. **83:** 543–544, 1926.
3. BRODSKY, I.: Atresia of the Duodenum: Report on Three Cases, Including Two in Consecutive Female Members of the Same Family. Australian & New Zealand J. Surg. **9:** 415–422, 1940.
4. BRYAN, R. C.: Congenital Occlusion of Small Intestine. Am. J. Surg. **37:** 297–304, 1923.
5. BUCHANAN, E. P.: Congenital Duodenal Obstruction from Anomalous Mesenteric Vessels. Am. J. Surg. **30:** 499–501, 1935.
6. BUCKSTEIN, J.: Clinical Roentgenology of the Alimentary Tract. Philadelphia, W. B. Saunders Co., 1940, pp. 290–293.
7. CALDER, J.: Two Examples of Children Born with Preternatural Conformations of the Gut. Med. Essays & Observations, Edinburgh **1:** 203–206, 1733.
8. CORDES, L.: Congenital Occlusion of the Duodenum. Arch. Pediat. **18:** 401–424, 1901.

9. DAVIS, D. L., AND POYNTER, C. W. M.: Congenital Occlusions of Intestines, with Report of a Case of Multiple Atresia of Jejunum. Surg., Gynec. & Obst. **34:** 35–41, 1922.

10. DONOVAN, E. J., AND LADD, W. E.: Congenital Malformations of the Stomach and Duodenum. In F. Christopher's Textbook of Surgery. Philadelphia, W. B. Saunders Co., 3d ed., 1942, p. 1160.

11. DUCKETT, J. W.: Intestinal Obstruction in Newborn (Atresia of Duodenum). Ann. Surg., **116:** 321–333, 1942.

12. ERNST, N. P.: Case of Congenital Atresia of the Duodenum Treated Successfully by Operation. Brit. M. J. **1:** 644–645, 1916.

13. FEGGETTER, S.: Congenital Duodenal Atresia; Successfully Treated by Operation. Lancet **2:** 188–189, 1940.

14. FELDMAN, M.: Clinical Roentgenology of the Digestive Tract. Baltimore, Wm. Wood & Co., 1938, pp. 399–409.

15. FORSCHNER-BÖKE, H.: Zur Klinik der angeborenen Duodenalstenose. Monatschr. f. Kinderh. **54:** 414–425, 1932.

16. FORSSNER, H.: Die angeborenen Darm- und Oesophagusatresien. Eine entwicklungsgeschichtliche und pathologisch-anatomische Studie. Anat. Hefte **34:** 1–163, 1907.

17. FRANK, E. S.: Chronischer Ileus des Duodenums bei Säuglingen durch periduodenale und peripylorische Membranen. Acta paediat. **10:** 302–320, 1931.

18. GLOVER, D. M., AND HAMANN, C. A.: Intestinal Obstruction in Newborn Due to Congenital Anomalies. Ohio State M. J. **36:** 833–840, 1940.

19. HALBERTSMA, T.: Zwei geheilte Fälle von Duodenalstenose bei Neonati. Kinderärztl. Praxis **10:** 522–524, 1939.

20. HARPER, R. A. K.: Congenital Duodenal Obstruction. Brit. J. Radiol. **14:** 360–363, 1941.

21. HUBER, H. G.: Ein Beitrag zur Duodenalstenose beim Neugeborenen. Kinderärztl. Praxis **9:** 415–422, 1938.

22. IMPINK, R. R., AND CLAMMER, G. R.: Atresia of Duodenum; Case Report. Ann. Surg. **116:** 334–336, 1942.

23. JACOBI, A.: Congenital Occlusion of Duodenum. Tr. N. Y. Path. Soc. **2:** 3, 1877.

24. KELLOGG, E. L., AND COLLINS, J. T.: Congenital Duodenal Obstruction. Am. J. Surg. **30:** 369–371, 1935.

25. KELLY, P. M.: Duodenal Atresia, with Case Report of a Successful Gastro-Enterostomy. Brit. J. Surg. **29:** 245–252, 1941.

26. KERLEY, C. G., AND LEWALD, L. T.: Digestive Disturbances in Infants and Children. Annals of Roentgenology, New York, Paul B. Hoeber, 1923, Vol. III, plate XXII.

27. KOCH, W.: Missbildungen des Magens und Darmes. In Henke-Lubarsch: Handb. d. spez. path. Anat. und Histol. Berlin, Springer, 1926, Vol. IV (1), pp. 189–196.

28. KRIEG, E. G.: Duodenal Diaphragm. Ann. Surg. **106:** 33–41, 1937.

29. LADD, W. E.: Congenital Obstruction of Duodenum in Children. New England J. Med. **206:** 277–283, 1932.

30. MARIS, E. P., AND OTHERS: Pre- and Postoperative Use of Metal-Tipped Gastroduodenal Tube as Aid in Surgical Treatment of Duodenal Obstruction in Newborn. Ann. Surg. **117:** 348–354, 1943.

31. MILLER, E. M., GREENGARD, J., RAYCRAFT, W. B., AND MCFADDEN, I.: Congenital Atresia of Duodenum and of Ileum; Report of 2 Cases with Successful Results Following Operation. Am. J. Dis. Child. **66:** 272–279, 1943.

32. MOISE, T. S., JR., AND STABINS, S. J.: Surgery of the Stomach and Duodenum. In Practitioners' Library of Medicine and Surgery. New York, D. Appleton-Century Co., Vol. IV, 1933, pp. 536–537.

33. MONTGOMERY, A. H.: Diseases of the Small Intestine. In Brennemann's Practice of Pediatrics. Hagerstown, Md., W. B. Prior Co., 1944.

34. MORTON, J. J.: Atresia of Duodenum and Right Internal Hernia. Am. J. Dis. Child. **25:** 371–378, 1923.

35. NEUHAUSER, E. B. D.: Roentgen Diagnosis of Fetal Meconium Peritonitis. Am. J. Roentgenol. **51:** 421–425, 1944.

36. PERMAN, E.: Einige Fälle von Atresia Duodeni. Acta paediat. **19:** 557–566, 1937.

37. POTTER, A. H.: Volvulus of Duodenum in Newborn. J. Pediat. **8:** 346–347, 1936.

38. ROSE, J., AND MAY, A. M., JR.: Congenital Duodenal Atresia. J. Pediat. **10:** 490–494, 1937.

39. SPRIGGS, N. I.: Congenital Intestinal Occlusion; An Account of Twenty-Four Unpublished Cases with Remarks Based Thereon and Upon the Literature of the Subject. Guy's Hosp. Records **66:** 143–218, 1912.

40. STETTEN, DEW.: Duodenojejunostomy for Congenital, Intrinsic, Total Atresia at Duodenojejunal Junction; Successful Result in Three-Day-Old, One-Month-Premature Infant Weighing Four Pounds, Two Ounces. Ann. Surg. **111:** 583–596, 1940.

41. TANDLER, J.: Zur Entwicklungsgeschichte des menschlichen Duodenums in frühen Embryonalstadien. Morphol. Jahrb. **29:** 187–216, 1902.

42. THORNDIKE, A., JR.: Duodenal Atresia and Stenosis in Infancy; Important Diagnosis; Case Reports. Boston M. & S. J. **196:** 763–768, 1927.

43. VAIL, A. D., AND SCHWARTZ, E. J.: Congenital Duodenal Obstruction. J. Missouri M. A. **39:** 12–18, 1942.

44. WANGENSTEEN, O. H.: Elaboration of Criteria Upon Which Early Diagnosis of Acute Intestinal Obstruction May Be Made, with Special Consideration of Value of X-Ray Evidence. Radiology **17:** 44–62, 1931. Also: Intestinal Obstructions. Springfield, Ill., Charles C Thomas, 2d ed., 1942, pp. 261–273.

45. WANKE, R.: Duodenalanomalien in Röntgenbild und ihre klinische und therapeutische Bedeutung. Fortschr. a. d. Geb. d. Röntgenstrahlen **39:** 249–262, 1929.

46. WARD, C. S., JR., AND COOPER, F. W., JR.: Atresia of Duodenum: Case Successfully Treated by Duodenoduodenostomy. Ann. Surg. **117:** 718–722, 1943.

47. WEBER, G.: Zur Diagnose und Klinik der angeborenen Duodenalstenose. Monatschr. f. Kinderh. **45:** 208–224, 1929.

48. WHITE, C. S., AND COLLINS, J. L.: Congenital Duodenal Obstruction. Arch. Surg. **43:** 858–865, 1941.

49. WIIG, L. M., AND CLAGETT, O. T.: Congenital Atresia of Duodenum. Proc. Staff Meet., Mayo Clin. **17:** 577–580, 1942.

50. ZIEGLER, W.: Über die angeborene Duodenalstenose im Kindesalter. Jahrb. f. Kinderh. **143:** 36–48, 1934.

Diverticulosis of the Jejunum and Ileum[1]

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DIVERTICULA are known to occur in practically every portion of the digestive tract. They are most common in the colon and are frequently found, also, in the esophagus and duodenum. Diverticulosis of the small bowel, however, is rare. A recent report by Benson, Dixon, and Waugh (1) states that at the Mayo Clinic, from 1909 to 1942, inclusive, there occurred 122 cases of non-meckelian diverticula of the jejunum and ileum, an average of less than 4 per year. These authors indicate that, in addition, there are only about 200 other recorded examples in the medical annals. Case (2) was able to find but 66 proved cases in the literature in the eighty-year period from 1844 to 1924.

In our clinic at the Boston City Hospital, we have observed a series of 25 cases of diverticulosis of the jejunum and ileum, all of which were seen in a period of two and a half years, from January 1942 to July 1944, and were diagnosed during routine studies of the gastro-intestinal tract with the opaque meal. Because of the relative infrequency of diverticula of the small bowel, it was felt worth while to record the clinical and roentgen manifestations of these cases.

PATHOGENESIS

Diverticula of the small intestine, in common with other types of diverticulosis, may be either congenital or acquired. In the congenital type, the pouch comprises all the layers of the small bowel, while in the acquired group there is a herniation of the mucosa through a defect in the muscular layer. Diverticula are usually, although not necessarily, found along the mesenteric border of the intestine. They may be either single or multiple. The size varies from a few millimeters to several centimeters in diameter. The pouches are usually smooth and rounded; in some instances they appear oval or elongated. The communication with the lumen of the small bowel is variable and may be large or small. The diverticula occur in any portion of the small bowel from the duodenojejunal junction to the ileocecal valve. The upper and middle thirds of the jejunum are the most usual sites, the ileum being the least frequently involved.

Inflammatory changes resulting in diverticulitis may be due to irritation or occlusion by fecal concretions and foreign bodies. Edema and local swelling produce stasis in the diverticulum. The inflammation tends to involve adjacent segments by direct extension and is accompanied by pain, tenderness, and spasm. Perforation may supervene with the formation of either a localized or, more frequently, a generalized peritonitis. In those instances in which the local inflammatory process subsides prior to perforation, areas of fibrosis with partial stenosis or complete obstruction may subsequently develop.

ETIOLOGY

The chief predisposing factors of diverticulosis of the small intestines may be summarized briefly as follows: (1) mechanical, associated with chronic constipation and long-standing over-distention, the pressure of the gas and fecal material forcing the mucosa through the muscularis; (2) degenerative changes, generally thought to be associated with old age, overweight, local irritation, and putrefaction, producing fatty degeneration of the musculature and loss of elasticity of the tissues, with consequent weakening of the intestinal walls. Diverticula appear also to have been caused by adhesions, scarring secondary to healed tuberculosis, and traction from a tumor.

[1] From the Department of Roentgenology, Boston City Hospital. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

INCIDENCE

Prior to the widespread use of the roentgen method of study of the gastro-intestinal tract, diverticula of the small intestine were practically never diagnosed clinically or at operation and were but rarely recognized at the autopsy table. Reinhardt (3), for example, found only 3 cases in 5,000 necropsies (0.06 per cent), and Edwards (4) 9 in 2,820 postmortem examinations (0.3 per cent). This low incidence may be explained by several factors. The pouches are usually collapsed and shrunken at the time of examination; also, the diverticula are difficult to find if they are empty and small, or in the presence of large amounts of mesenteric fat. Moreover, in many cases thorough search of the entire alimentary canal is not carried out and inflation of the intestines is not practised routinely by many pathologists.

The number of diverticula of the small bowel in series of cases previously observed roentgenologically is likewise very small. Jenkinson (5) found but 3 instances in many thousands of roentgen studies of the gastro-intestinal tract during a period of ten years. Rankin and Martin (6) stated that diverticulosis of the small bowel, exclusive of the duodenal and meckelian types, was found only once in approximately 25,000 examinations; and other observers (7) have likewise reported a very low incidence. With the wider use of the roentgen method of study of the gastro-intestinal tract, these lesions will be discovered with ever-increasing frequency and will prove to be much more common than previously supposed. It is quite probable that many cases are being overlooked even now. As the clinician and roentgenologist are impressed with this fact and become more alert in the search for diverticula of the small intestine they will be diagnosed in far greater numbers in the future.

In our clinic, there were observed 25 cases of diverticulosis of the jejunum and ileum in a period of thirty months. During this time, there were carried out 4,786 roentgen studies of the gastro-intestinal tract with the opaque meal, making an incidence of 0.5 per cent. All the cases were diagnosed during routine examinations, which comprised fluoroscopic studies and roentgen films of the esophagus, stomach, duodenum, and upper jejunum at the time of ingestion of the opaque meal, subsequent observations after an interval of six hours, and in some instances a twenty-four-hour study. Serial examinations of the small bowel were not done in the greater majority of the patients, being performed only when the routine study indicated that they might prove worth while. For comparison, it may be pointed out that diverticulosis of the colon occurs in from 3 to 10 per cent of all patients (8); and that the incidence of diverticulitis of the large bowel may be as high as 34 per cent (8) of this group. Diverticulitis of the small bowel is very rare, however, and was not seen in any of the cases observed by us.

Diverticulosis of the small intestine appears to be a condition seen primarily in middle and late adult life. Only one of our patients was in the third decade; 3 were in the fifties; the remaining 21 patients were over sixty years old, with one each 75, 78, and 82 years of age. The average age for the entire series was 65 years. The sex ratio was practically equal, 12 females and 13 males.

The distribution, size, and number of lesions in the present series is of interest:

		Cases
A.	Distribution	
	Jejunum alone	20
	Jejunum and ileum	4
	Ileum alone	1
	Entire jejunum	5
	Upper third of jejunum	12
	Middle third of jejunum	6
	Lower third of jejunum	2
	Entire ileum	1
	Upper ileum	2
	Mid-ileum	2
B.	Size of lesion	
	Over 3 cm. diameter	5
	From 1 to 3 cm. diameter	15
	Less than 1 cm. diameter	5
C.	Number	
	Single diverticulum	10
	2–4 diverticula	10
	5 or more diverticula	5

SYMPTOMS

There is no definite syndrome associated with diverticulosis of the small intestine. In many instances, the diverticula are found during routine roentgen studies of the gastro-intestinal tract and have apparently been present for long periods of time without having produced any evidence of their presence. Moreover, many patients with diverticulosis of the jejunum and ileum have gallbladder disease, peptic ulcer, hiatus hernia, heart conditions, etc., which may be causing symptoms, thus increasing the difficulty of determining whether the complaints are associated with the diverticula or are due to other conditions. Despite the difficulties of differential diagnosis, however, it appears that small intestinal diverticulosis not infrequently gives rise to symptoms that should suggest the diagnosis clinically. The complaints vary from mild, chronic abdominal pain or soreness, accompanied by a feeling of "gas-on-the-stomach," to more severe epigastric distress with nausea and vomiting. The symptoms are usually intermittent in character with a tendency to remissions and exacerbations over periods of months or years. There is, as a rule, no demonstrable relation to meals, bowel movements, or exertion. With distention of the sac, there may occur fullness, cramps, and abdominal pain, either dull or acute in character.

Three of the patients in our series had no complaints referable either directly or indirectly to the diverticulosis. Of this group, two were studied because of generalized superficial adenopathy; the third because of the presence of an abdominal mass. Routine roentgen studies with the opaque meal were carried out in a search for malignant disease of the gastro-intestinal tract, the diverticula being incidental findings.

The remaining 22 patients presented abdominal complaints. These varied widely in duration and severity. In one patient, the symptoms were of but two weeks' duration; at the other end of the scale was a story dating back fifteen years. The commonest complaint was epigastric distress, which was present in every instance at some time during the history. Eructations of gas were usually associated with the distress. In approximately 50 per cent of the group there was anorexia. Nausea and vomiting were noted in 10 instances. The vomitus consisted principally of undigested food and was small or moderate in amount. In the intervals between attacks of distress and vomiting, there was a feeling of heaviness and gas in the upper abdomen.

Four patients gave a history of tarry stools. One of these had an esophageal hiatus hernia, which was the probable source of the bleeding. The remaining three showed no lesion in the gastro-intestinal tract other than diverticulosis of the small intestine. Two of our group had undergone cholecystectomy, only to return to the hospital after an interval of two or three years, stating that the operations had produced no relief and presenting the same abdominal complaints as previously. Thus, in older people with indefinite abdominal complaints suggestive of peptic ulcer or gallbladder disease, but with no abnormalities demonstrable in these regions, the possibility of diverticulosis of the small bowel must be borne in mind as a cause of the symptoms.

As is the case with diverticula elsewhere in the body, these lesions may be present in considerable numbers, attain relatively large size, and exist for comparatively long periods, without producing complaints or otherwise giving evidence of their presence. On the other hand, they may cause symptoms and must be considered a potential source of danger in view of the ever-present possibilities of retention and stasis of food, secretions, and foreign bodies, infection, perforation, and rupture or stenosis. It is important that the clinician be aware of their existence in any patient under his care. Since these diverticula may not be demonstrable at operation even when one of the above complications has supervened, because of the difficulties involved in exploration of the entire small bowel, the responsibility rests mainly in the

Fig. 1. Large diverticulum of the upper jejunum.

hands of the roentgenologist. We must therefore be constantly on the lookout for these lesions and utilize every method of demonstrating them in every suspected case.

If acute diverticulitis of the small bowel develops, the symptoms may, as in colonic diverticulitis, be closely similar to those of appendicitis except for the difference in the location of the pain, tenderness, and spasm. Nausea and vomiting are more apt to occur with inflammation of small bowel diverticula because of their much higher location in the gastro-intestinal tract.

ASSOCIATION WITH OTHER LESIONS

Case (2), writing on this topic twenty years ago, noted the frequent association of diverticulosis of the small bowel with diverticula and other congenital anomalies elsewhere in the body. In our series, likewise, there was found to be an unusually high incidence of diverticula of the duodenum and colon and, also, esophageal hiatus hernia with protrusion of a portion of the stomach through the esophageal orifice of the diaphragm. Eleven of our patients presented diverticula of the duodenum. Of these, 8 were in the descending portion, 3 were in the cap or bulb, and 1 was in the third part. One patient had two duodenal diverticula, one each in the second and third portions. Thus it will be noted that in 44 per cent of our cases there was simultaneous diverticulosis of the duodenum and small intestines, an incidence too high to be coincidental and indicative of the fact that similar factors are doubtless present in the various portions of the alimentary tract to account for the presence of the diverticula.

Fig. 2. Solitary diverticulum of the jejunum.

In 6 of our cases of diverticulosis of the small bowel, there were also diverticula of the colon, an incidence of 24 per cent. There was only one instance of esophageal diverticulosis. This patient was of unusual interest, however, in that he presented three diverticula of the esophagus, a large diverticulum of the second portion of the duodenum, a dumb-bell shaped diverticulum of the upper jejunum, multiple diverticula of the colon, and a small esophageal hiatus hernia.

Worthy of note, also, was the finding of five cases of esophageal hiatus hernia in our series, with protrusion of a portion of the cardia of the stomach through the esophageal orifice of the diaphragm into the thorax. Two of the hernias involved approximately one-half of the stomach; the others were small. This incidence of hiatus

hernia, 20 per cent, is also distinctly above the average.

ROENTGEN DIAGNOSIS AND METHODS OF STUDY

In most clinics, in performing routine roentgen studies of the gastro-intestinal tract, a preliminary film of the abdomen is taken. A gas-filled diverticulum may occasionally be demonstrable at this time.

Fig. 3. Large diverticulum of the jejunum, indicated by the arrow. Other smaller jejunal diverticula are also visible, one overlying the spine and two in the left upper quadrant.

Accurate diagnosis of diverticulosis, however, is not possible by this means, and full reliance cannot be placed on this method alone. Roentgen diagnosis of diverticulosis of the small bowel is dependent on the demonstration of the barium-filled pouch or pouches adjacent to and communicating with the lumen of the intestine. The sacs are usually rounded or oval in shape and may be partially or completely filled with the opaque material. With the patient erect, the barium mixture occupies the dependent portion of the diverticulum and forms a horizontal fluid level with a gas shadow in the upper portion of the sac. In lateral decubitus, similar findings are present. In some instances, there is a layer of slightly increased density between the barium and gas shadows described above, this zone being due to intestinal contents and secretions.

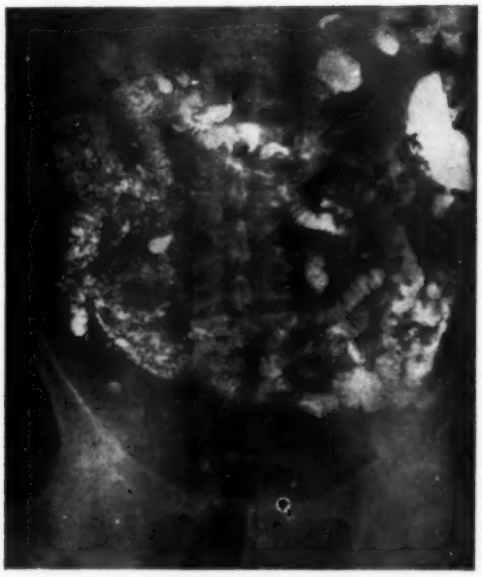

Fig. 4. Multiple diverticula scattered throughout the small bowel (straight arrows). Diverticula of the colon with retained barium from a previous opaque enema (curved arrows).

In the presence of a diverticulum, thorough roentgenoscopic observations with manual palpation should be carried out in all positions, including the upright, to determine mobility, spasm, and tenderness. Diverticula of the upper jejunum may be best observed within a few minutes to an hour after the ingestion of the opaque meal. Those occurring lower in the jejunum and ileum may not be visualized until three, six, or twenty-four hours later. In many clinics, during routine examination of the gastro-intestinal tract, little if any attention is paid to the small bowel. The six-hour observation is used in many instances to determine whether or not there is gastric stasis and to note the position of the head of the barium column. Not infrequently the entire small bowel is practically empty at this time. Unless there is stasis in the diverticula, they will be entirely overlooked and the diagnosis missed, their presence not even being suspected.

While in most clinics it is not practicable to carry out special studies of the small

Fig. 5. Multiple diverticula of the small intestine.

bowel in all cases, it is definitely possible to miss many cases of diverticula of the small intestines unless particular attention is paid to the passage of the opaque meal through the various segments of the jejunum and ileum. Roentgenoscopic observations of the stomach and duodenum should always include study of the upper jejunal loops. Diverticula in this area may be obscured by the overlying stomach and are demonstrable only by manual displacement of the stomach during roentgenoscopy or the use of lateral and oblique views. If there is any clinical suggestion of disease of the small bowel, observations should be made at intervals of one to two hours after the ingestion of the opaque meal until all the loops have been visualized. Also, at the twenty-four hour observation, retention in diverticula should be carefully sought for. If stasis in the pouch is present, observations should be continued daily until complete emptying has taken place.

During opaque enema studies, filling of the terminal loops of ileum is frequently possible, affording an opportunity to examine this portion of the alimentary tract. More common use of the so-called "small-bowel enema," in which the barium mixture is introduced through a tube lying in the duodenum will permit of complete and accurate study of the small intestine. With marked delay in the motility of a foreign body, the possibility that it is retained in a diverticulum must be borne in mind, and opaque meal studies carried out for localization. We are constantly impressed by the fact that so little attention is paid to the small bowel in many clinics. This is deplorable, as important lesions of the jejunum and ileum may be overlooked because of this carelessness.

TREATMENT

Therapy of the patient with diverticulosis is directed primarily to the avoidance of all factors which may result in the development of obstruction or diverticulitis, there being no form of medical treatment which directly influences the diverticula themselves. Over-distention of the intestinal tract, constipation, and stasis are to be particularly avoided. Obesity appears to be an important factor and should be controlled by dietary measures. A low-roughage diet is indicated. Our cases were treated with bed-rest for periods varying from one to eight weeks in duration, no special dietary restrictions other than the above being imposed. This usually produced relief, and all were improved at the time of leaving the hospital. Surgical approach is not difficult, as the lesions are easily mobilized and can usually be brought into the operative field with relative ease. Therefore, if the symptoms are sufficient to warrant laparotomy, there can be no objection to operation, and the mortality should be no greater than in appendectomy or similar abdominal operations.

SUMMARY

Diverticula of the jejunum and ileum are relatively uncommon, but with modern roentgen methods of diagnosis are found to occur much more frequently than was previously supposed. The present report comprises a series of 25 cases observed at the Boston City Hospital.

The roentgen and clinical manifestations of diverticulosis of the small intestine are described.

An unusually high incidence of diverticula elsewhere in the gastro-intestinal tract and also of esophageal hiatus hernia was found in our series.

If the clinician is not aware of the presence of the diverticula, the patient may be subjected to long periods of unnecessary medical treatment and needless surgery, or be dubbed a neurotic.

The responsibility for the diagnosis of diverticulosis of the small intestine rests practically solely in the hands of the roentgenologist.

Careful observations of the entire small bowel are essential for the demonstration of the diverticula.

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REFERENCES

1. BENSON, R. E., DIXON, C. F., AND WAUGH, J. M.: Nonmeckelian Diverticula of the Jejunum and Ileum. Ann. Surg. **118:** 377–393, 1943.
2. CASE, J. T.: Jejuno-Ileal Diverticula. Acta radiol. **6:** 230–240, 1926.
3. REINHARDT: Multiple Divertikel des Jejunum. Zentrbl. f. Chir. **53:** 1091–1092, 1926.
4. EDWARDS, H. C.: Diverticulosis of the Small Intestine. Ann. Surg. **103:** 230–254, 1936.
5. JENKINSON, E. L.: Diverticula of the Small Bowel. Radiology **12:** 100–104, 1929.
6. RANKIN, F. W., AND MARTIN, W. J., JR. Diverticula of the Small Bowel. Ann. Surg. **100:** 1123–1135, 1934.
7. VAN RAVENSWAAY, A. C., AND WINN, G. W.: Jejunal Diverticula: Consideration of Clinical Symptomatology and Case Report. Am. J. Digest. Dis. **10:** 108–111, 1943.
8. YOUNG, E. L., AND YOUNG, E. L., III: Diverticulitis of the Colon: Review of Literature and Analysis of 91 Cases. New England J. Med. **230:** 33–38, 1944.

DISCUSSION

(Papers by Kautz, Lisa, and Kraft, and by Ritvo and Votta)

Ross Golden, M.D. (New York): At our institution the x-ray examination of the infant is done by Dr. John Caffey, in the Babies' Hospital. Therefore, I know little about duodenal obstruction and will not attempt to discuss it. However, I would like to point out that in two cases I have seen, the obstruction at the junction of the first and second portions of the duodenum was due to an extrinsic peritoneal band which in one instance caused the death of the patient and in another instance was relieved by a timely operation.

Dr. Ritvo's presentation leaves little to discuss. I would like to point out, however, that in my experience the symptoms which he has mentioned as associated with diverticulosis of the small intestine are rather non-specific and I just wonder how far we ought to go in attributing them to, or associating them with, the diverticulosis. His warning that other disease may exist along with the diverticula I think is very timely. He spoke in an etiological sense about a possible relation between constipation and the development of these diverticula. I don't quite understand how constipation, which is a disorder of the large intestine, would manifest itself by producing a diverticulum in the upper part of the small intestine, because there is too much flexible wall of intestine to take up variations of pressure in between. In the cases I have seen there has been no evidence of back pressure in the way of delayed passage of barium or otherwise which one could attribute to constipation.

William E. Anspach, M.D. (Chicago, Ill.). I have had experience with quite a number of the congenital lesions of the duodenum in children presented so clearly in the paper by Drs. Kautz, Lisa, and Kraft. Because of the vomiting, an obstruction is suspected, and the logic of oral administration of barium comes in question. The danger of thus completing the obstruction was emphasized in one case, in a three-year-old child who had survived without surgical intervention and then died thirty-six hours after administration of barium by mouth. This was the first demonstration of the enormous dilatation of the proximal half of the duodenum. The physician blamed the barium for the complete obstruction and I could not disagree with him. At present another child has lived eight months without surgery. It is surprising how well some of these children look, even though all of the food has to pass through a lumen often less than 2 mm. in diameter. Surgery has offered little in the cases coming our way. Nearly all have proved fatal.

If the roentgenologist will see that all chest roentgenograms of children are made in the upright position, this peculiar lesion may be discovered without the use of barium. The two large typical gas pockets (duodenum and stomach) usually have accompanying fluid levels. These were beautifully illustrated in 4 of Dr. Kraft's 6 cases. This is the most common or, we might say, the garden variety of congenital atresia of the small bowel. It is well to remember that this lesion is near the upper end of the small intestine and occurs with about the same frequency as atresia in the upper third of the esophagus. While most often one finds only an atresia of the duodenum, occasionally constricted zones in other portions of the small bowel are accompanying

defects and they must be sought in all cases coming to surgery.

Lewis Gregory Cole, M.D. (White Plains, N. Y.): As for this lesion (diverticula of the small intestine) being one of recent recognition by roentgenologists, I would call attention to several elaborate articles published in the early nineteen hundreds: one by Case, which Dr. Ritvo mentions, one by Dudley Roberts and myself, and several others since then.

After the first flurry of recognizing these as a pathological entity had subsided, I believe that the consensus of opinion was that they seldom were the cause of symptoms, and that when they were present and the patient had gastro-intestinal symptoms, there was no assurance that these were due to the diverticula and, furthermore, that recognition of them frequently led to surgical intervention that all too often terminated fatally.

Since the late teens this subject has come up for discussion from time to time, often with the same trend of thought, that these should be recognized and considered as a potential cause of symptoms, perhaps requiring surgery. Finding these diverticula is like finding a four-leaf clover, if one's eyes are trained to see them. One picks so many of these up in routine roentgenological procedure that it often seems wise not to report them lest some surgeon should search for them with disastrous results. At operation they are very difficult to find in the duodenum; they often occur in the retroperitoneal portions, and the surgeon sees no evidence whatever of them as he inspects the visible and palpable portions of the gut.

Ernest Kraft, M.D. (*closing*): In reply to Dr. Golden, we differentiate between extrinsic and intrinsic factors of duodenal obstruction. In our last case there were two factors involved. There was a peritoneal band across the duodenum, and at the same level the pathologist found also an obstructing membrane within the duodenum.

Dr. Anspach mentioned multiple atresia, a condition which is extremely rare. I hope he will give us a complete paper on this.

In spite of the interest in subtotal and partial stenosis I wanted particularly to emphasize the complete obstruction with alarming symptoms in the newborn immediately after the first feeding. If infants are not operated on without delay, they will go down hill very rapidly and die within a week or two. I think we roentgenologists could do a great deal of good by co-operating with surgeons and other specialists, going to the operating room and helping the surgeon find the duodenal obstruction. We may see great distention of the stomach and duodenum. Unfortunately, later on, when the infant vomits and deflation becomes complete, the surgeon may not be able to discover the obstruction.

Pellegrini-Stieda Disease[1]

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OUT OF A SERIES of 9,218 examinations in the X-Ray Department of an Army General Hospital, we have seen 8 cases of an interesting and somewhat rare clinical entity which was first described by Pellegrini in 1905 (5) and by Stieda in 1908 (10). Since that time, this post-traumatic entity has been known as Pellegrini-Stieda disease. It might perhaps better be called post-traumatic calcification in the paraarticular region of the knee.

In 1938 Pellegrini (6) reported on 767 cases found in the literature up to that time. It has been the experience of most authors, however, that the disease is much less frequent than that figure would indicate. Kulowski (4), in March 1942, was able to find only 60 cases reported in the English literature.

Köhler (3) states that the onset of calcification occurs not less than three weeks following the initial trauma, and we recently have seen a case in which films taken at the time of injury showed no calcification while a film one month later revealed the typical calcification characteristic of the disease (Figs. 1 and 2). It is also the opinion of most authors (3, 4, 9) that this process develops only in patients who give a history of trauma to the knee, and that fact has been borne out in all the cases which we have seen.

Three main theories have been developed concerning the etiology of this disease. They are: (*a*) separation of a bony fragment (10); (*b*) periosteal tear due to avulsion or tearing out of the medial collateral ligament with subsequent calcification (2); (*c*) development of a small hematoma within the connective tissues with subsequent calcification (7). There is, however, considerable difference of opinion in the literature as to the exact cause of the condition. Pellegrini himself (5) felt that the calcification was due to subperiosteal hemorrhage and metaplasia of the medial collateral ligament, and we believe that this theory explains more of the findings than any of the other suggested etiological possibilities. In one of our cases (Case 1) we noted just above the medial epicondyle a small linear area of subperiosteal calcification which we interpreted as being due to periosteal tear and hemorrhage with subsequent calcification (Fig. 2). Another of our patients (Case 3) sustained a fracture of the clavicle in the African campaign, when a large G. I. truck in which he was riding overturned. This injury is mentioned here, as it showed the tendency in this individual to the deposition of calcium in the soft tissues. This tendency has been mentioned as one reason why a certain percentage of those receiving injuries to the knee go on to the development of calcification in the soft tissues while others do not.

Calcification of the medial collateral ligament is a rare affliction, occurring usually in men between the ages of twenty-five and forty years. Clinically, most cases give a history of trauma to the knee, usually occurring when it is flexed and the leg is outwardly rotated. This trauma may be of the single violent type but more often takes the form of repeated minor injuries. Most of the patients will continue to have trouble with recurring attacks of pain and/or swelling, the complaint often being, "My knee locks on me." There is usually definite tenderness over the involved area, and tension on the ligament accentuates the pain. The patient is likely to hold the involved joint in slight flexion.

The roentgenogram is the diagnostic factor in these cases, revealing a crescent-shaped area of calcification directed either vertically or obliquely in the soft tissues just medial to the inner condyle of the femur and appearing to cap the epicondyle. Characteristically, there is a clear radiolu-

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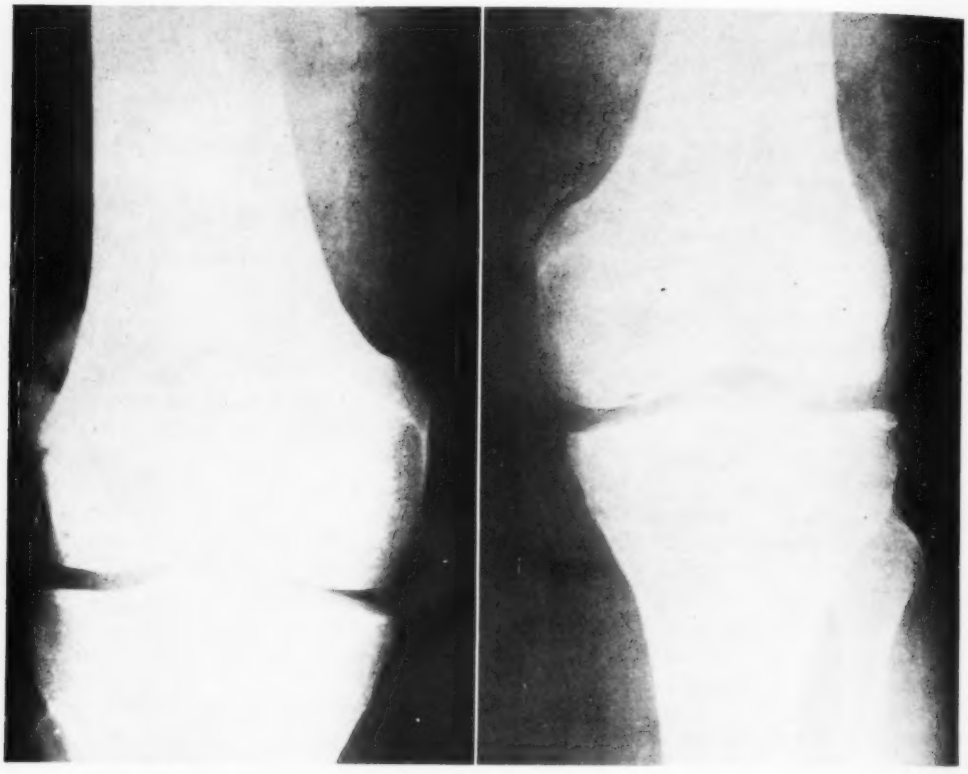

Figs. 1 and 2. Case 1. In the roentgenogram (left) taken at the time of injury no pathological changes were demonstrated. A tripartite patella is present. A roentgenogram (right) taken forty-one days later shows a soft, indistinct calcific shadow capping the medial epicondyle. There is also subperiosteal calcification just proximal to the condyle. This is the typical roentgen appearance of the early or evolutive phase of Pellegrini-Stieda disease.

cent space of varying degree between the shadow and the femoral condyle. Subperiosteal reaction may be seen occasionally along the inner margin of the shaft of the femur, just above the epicondyle.

Two main types of the entity are described radiologically. They are the evolutive type and the stabilized type. The evolutive type appears as a hazy or fuzzy opacification which is not clearly demarcated from the epicondyle, while in the stabilized form we see a dense, sharply outlined ossified shadow clearly separated from the epicondyle.

The treatment will vary depending on the stage of the disease and the amount of discomfort present. Surgical excision (2) should be done if the condition provokes clinical discomfort, but only after the process has reached the stabilized form. Some cases have apparently healed spontaneously (9). Lately, x-ray therapy has been tried in the acute cases (4), but no definite statement as to its value has been made.

CASE REPORTS

CASE 1: The patient, 24 years old, fell and injured his left knee on Jan. 14, 1944, jumping from a wall. The knee was immediately splinted and the patient was evacuated to the rear. The impression at that time was of an acute sprain, and roentgenograms taken at the Evacuation Hospital showed no fracture (Fig. 1). Films taken at our hospital (Fig. 2) on Feb. 25, forty-one days following the injury, showed a large crescent-shaped shadow of calcification capping the medial epicondyle of the femur, with a clear radiolucent area between this shadow and the epicondyle. A small area of periosteal elevation with subperiosteal calcification was also present, just proximal to the epicondyle. There

was a tripartite patella. The film of the opposite knee was negative.

CASE 2: A man 32 years of age fell from a truck in January 1943, injuring his knee. The knee was swollen and painful for several weeks and the patient received physiotherapy. A second injury to the same knee was sustained in April 1943, and recurrent attacks of pain and swelling followed.

Fig. 3. Case 2. Roentgenogram showing the typical calcific shadow capping the medial condyle, roughening of the periosteum just proximal to the condyle, and atrophy of disuse. The dense crescent-shaped calcific shadow capping the medial condyle, and clearly separated from it, is characteristic of the late or stabilized form of Pellegrini-Stieda disease.

On May 1, 1943, a medial meniscectomy was done. The patient entered our hospital the latter part of June 1943, stating that his knee had been weak ever since the operation. A film made in July (Fig. 3) showed the typical dense, crescent-shaped area of calcification capping the medial epicondyle plus very minute roughening of the periosteum above the epicondyle. There was also interosseous bone production and some atrophy of disuse about the knee. These additional changes may well be the result of the previous operation.

CASE 3. The patient, a man of 21, injured his

Fig. 4. Case 3. Roentgenogram of the affected knee showing the dense crescent-shaped calcific shadow along the medial margin of the medial condyle.

right knee while playing football, in the fall of 1940, and had experienced intermittent attacks of pain and locking of the knee ever since. Physical examination showed slight tenderness along the margin of both sides of the knee joint. Roentgenograms (Fig. 4) taken in July 1943 showed the typical dense, sharply outlined, crescent-shaped calcific mass overlying the medial epicondyle. A film of the right shoulder, made two weeks following a fracture of the clavicle sustained in the African campaign, showed roughening and irregularity of the distal ends of the clavicle. The most striking thing, however, was the bizarre appearing calcific mass extending between the clavicle and scapula, which had apparently developed fairly rapidly following the injury.

CASE 4: A man of 25 years, admitted to our hospital for dislocation of the left knee, gave a history of injury while playing football in 1936. He had experienced recurring dislocation of the knee since that time. X-ray examination showed slight narrowing of the joint space along the medial half of the knee. There was also demonstrated the typical crescent-shaped calcific area capping the medial epicondyle and separated from it by a well demarcated area of decreased density.

Fig. 5. Case 6. Roentgenogram showing the crescent-shaped area of calcification capping the medial condyle, indistinctly outlined in this case.

CASE 5: A man of 27 years sustained a dislocation of the left knee in December 1936, in an automobile accident, and had suffered from frequent attacks of pain and locking of the knee since that time. Roentgenographic examination showed early hypertrophic changes and also the typical crescent-shaped calcification of Pellegrini-Stieda disease.

CASE 6: A 30-year-old soldier injured his knee in April 1943, jumping in a foxhole during the African campaign. He was treated for sprain, but the knee continued to bother him. He was admitted to our hospital in July 1943, because of the sprain. On admission, the knee was moderately painful and the patient seemed to hold it in partial flexion. X-ray examination (Fig. 5) showed the characteristic crescent-shaped area of calcification capping the medial epicondyle. This area of calcification was not sharply outlined, and the radiolucent area usually well shown between the calcific mass and epicondyle was hazy in appearance and poorly defined.

CASE 7: A man of 24 years had injured his left knee playing football in 1937 and complained of recurring attacks of pain and giving way of the knee since that time. He re-injured the knee jumping out of a half-truck during the Tunisian campaign. On admission to our hospital, there were limitation of flexion and slight pain over the medial side of the knee. An x-ray examination (Fig. 6) showed a somewhat vermiform area of calcification along the border of the medial epicondyle and extending obliquely across the superior border of the epicondyle.

Fig. 6. Case 7. Roentgenogram showing a small oblong area of calcification in close proximity to the proximal portion of the medial condyle of the femur.

CASE 8: The patient was a man of 21 years. In March 1943, while prying loose some rocks with a pick, he slipped and fell on his left knee The knee was swollen and painful for one week, after which the pain and swelling subsided, but the patient continued to note a "grating" sound whenever the knee was flexed. He was inducted into the army and was able to complete basic training but was given light duty because of recurring attacks of pain and swelling of the knee. The x-ray showed a fusiform area of calcification overlying the medial epicondyle with a clear radiolucent area between the calcific area and the femoral condyle. An oblong area of calcification was observed in the posterior region of the knee joint just above the posterior margin of the tibia. There was an os fabella present.

There was also a linear patchy appearing area of calcification in the region of the suprapatellar bursa.

CONCLUSIONS

1. Eight cases of Pellegrini-Stieda disease are added to those in the literature.
2. All cases studied showed a characteristic roentgen appearance, namely, a crescent-shaped area of calcification capping the medial condyle of the femur.
3. A tendency to deposition of calcium in other parts of the body was observed in two of the cases.
4. Evidence of subperiosteal tear and subsequent calcification was noted in one case.
5. All cases studied gave a history of previous trauma to the knee.

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REFERENCES

1. CAMPBELL, WILLIS C.: Operative Orthopedics. St. Louis, Mo., C. V. Mosby, 1939, pp. 435–436.
2. KEY, JOHN A., AND CONWELL, H. EARLE: Management of Fractures, Dislocations, and Sprains. St. Louis, Mo., C. V. Mosby, 3d ed., 1942, p. 1054.
3. KÖHLER, ALBAN: Röntgenology. English translation by A. Turnbull. London, Bailliere, Tindall & Cox, 2d ed., 1935, pp. 188–190.
4. KULOWSKI, J.: Post-Traumatic Para-Articular Ossification of the Knee Joint (Pellegrini-Stieda's Disease). Am. J. Roentgenol. **47:** 392–404, March 1942.
5. PELLEGRINI, A.: Ossificazione traumatica del ligamento collaterale tibiale del' articolazione del ginoccio sinistro. Clin. mod. **11:** 433–439, 1905.
6. PELLEGRINI, A.: Ossificazione post-traumatische para-articulori (O.P.P.). Arch. ital. di chir. **53:** 501–563, 1938. Cited by Kulowski.
7. PFISTER, A.: Beitrag zur Kenntnis der posttraumatischen Ossificationen. Arch. f. klin. Chir. **89:** 855–872, 1909. Cited by Köhler.
8. RITVO, M., AND RESNIK, J.: Pellegrini-Stieda's Disease. Am. J. Roentgenol. **32:** 189–195, 1934.
9. SHANDS, ALFRED R., JR., AND RANEY, RICHARD B.: Handbook of Orthopedic Surgery. St. Louis, Mo., C. V. Mosby, 2d ed., 1940, pp. 403–404.
10. STIEDA, A.: Über eine typische Verletzung am unteren Femurende. Arch. f. klin. Chir. **85:** 815–826, 1908. Cited by Köhler.

Spondylolisthesis

Further Remarks with Emphasis on Radiologic Aspects[1]

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THE SCOPE OF this article is supplementary. It is intended to reaffirm most of the cardinal roentgen criteria for the diagnosis of prespondylolisthesis and spondylolisthesis described in detail in a previous publication (1). It is also intended to correct or modify some earlier impressions, as well as to add a few new observations.

Our findings, as originally noted, were based on 15 cases. Since then, an additional 55 cases have been collected, bringing the total to 70 at this writing. The following statistical, radiologic, and clinical comments are based on a study of the complete series. For purposes of brevity and economy, additional illustrations are not included at this time, particularly since the radiographic demonstration of the classical defect, with which we are chiefly concerned, was adequately covered in the original communication.

DEFINITION

Spondylolisthesis is a forward or anterior displacement of the spine because of the presence of an osseous defect in the posterior neural arch. More specifically, the defect is found in the pars interarticularis or isthmus, *i.e.*, that portion of the neural arch where the lamina, thexsuperior articular process, the inferior articular process, and the pedicle meet. This defect is bilateral, and the forward slipping of the spine occurs slowly, increasing progressively as multiple minimal traumata are added upon a mechanically weak back This forward slipping occurs at the point immediately above and anterior to the site of the defect.

Prespondylolisthesis is the term used to signify merely the presence of the defect described above. This defect may be either unilateral or bilateral, whereas in spondylolisthesis it is almost always bilateral. This is one distinction between the two lesions. More important is the fact that in prespondylolisthesis there is *no* forward slipping of the vertebra, merely the presence of a defect in the isthmus, bilateral or unilateral, the former predominating. Spondylolysis is a synonymous descriptive term, but we prefer to speak of prespondylolisthesis and spondylolisthesis because of the obvious relationship of the two words, the former referring to the presence of a defect without slipping, the latter to the added condition of forward slipping. For further convenience in description, the extent of forward displacement is referred to as first, second, third, or fourth grade, depending on where the posterior surface of the adjacent lower vertebra lies with respect to the posterior inferior angle of the vertebra involved. First grade would represent the minimum and fourth grade the maximum degree of forward slipping.

GENESIS

The time of origin and reason for occurrence of the isthmus defect are still a controversial subject. Both sides present good arguments in favor of their views as to whether the lesion is congenital or acquired. Most orthopedic men hold to the congenital origin. We feel, as originally and more fully expressed, that the work of Hitchcock (2) merits serious consideration. The defect is found in an area abounding with developmental anomalies. Hitchcock has indicated that the center of ossification for the formation and growth of each side of the posterior neural arch lies in the pars interarticularis. It has also been shown that the isthmic area is occupied by blood vessels almost sinusoidal in structure, which structurally weakens this zone. These factors lead us to believe that in a

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certain percentage of individuals the isthmic area is developmentally weak, and that superimposed trauma occurring anywhere from birth to several years later results in interference with complete solid ossification. Hitchcock describes the isthmic region as remaining cartilaginous up to and after birth, so that traumata incurred at birth or later could interfere with ossification. The absence of callus in the face of trauma as a cause is no argument against the above thesis, as we feel that a vascular disturbance occurs which, in view of lack of immobilization, is never corrected. Hence no osseous union. This view is confirmed in part by the appearance of some of the defects, which suggests the presence of an osteochondritis. In these cases, fragmentation, sclerosis, and lack of union may be seen. In other cases, where the defect is smooth and clean-cut, the explanation is comparable to what occurs in fractures where immobilization has been inadequate, so that delicate blood vessels striving to cross the site of the defect meet an impenetrable fibrous barrier.

On the other hand, we feel strongly that trauma *per se* is not the entire explanation. A sound isthmus, even though subjected to the most severe type of injury, resulting in comminuted fractures of the vertebral body, has never been seen to be disturbed. The body of the vertebra, the transverse processes, the inferior and superior articular processes, and even the spinous process may be fractured, but the isthmic portion remains unscathed if it is structurally sound to begin with. Our conclusion, therefore, is that one must have an inherently weak isthmus (developmental factor) *plus* trauma, either single or repeated, to produce the classical defect. The weight of the evidence so far presented must lead to this conclusion as the most logical one.

INCIDENCE

The literature places the incidence of spondylolisthesis at approximately 5 per cent. This figure was duplicated in the examination of 100 soldiers selected because of complete lack of back symptoms (M. Freedman). Our figures are as follows: 811 radiographic examinations directed to the lumbar and sacral areas of the spine revealed 70 cases, approximately 8.5 per cent, with irrefutable roentgen evidence of prespondylolisthesis and spondylolisthesis. An analysis of the findings is indicated in Table I. Fifteen additional cases were finally discarded because the findings were not definite enough from the radiographic standpoint. We tried to adhere rigidly to the roentgen criteria essential to the diagnosis, but we feel that a certain number of these discarded cases represented atypical forms of the lesion or lesions which could not be adequately demonstrated. If this assumption is admissible, the incidence would be much closer to 10 per cent, as we have from the beginning contended to be the case.

TABLE I: TYPE OF LESION FOUND, ITS LOCATION AND FREQUENCY

Examinations	Prespondylolisthesis—Unilateral	Prespondylolisthesis—Bilateral	Spondylolisthesis
811	5th L. V. (2) 4th L. V. (0)	5th L. V. (18) 4th L. V. (1)	5th L. V. (46) 4th L. V. (3)

Our explanation for this higher rate of incidence is as follows. In part, it may be attributed to the fact that we are dealing solely with the age group most apt to reveal this lesion. To this is to be added the factor of violent exercise and trauma so much the part of a soldier's life. We also believe that a thorough concept of the anatomy of the part involved and a sound knowledge of how to demonstrate the defect radiographically must result in the detection of a number of cases that would otherwise escape unnoticed. To confirm further the correctness of this statement we present Table II. Here it will be seen that radiographic study especially designed to demonstrate the defect revealed by far the highest number of positive findings.

It may be apropos at this time to comment upon the fact that a rate of incidence is not merely a matter of cases studied divided by the number of positive cases

TABLE II: ANALYSIS OF THE PART SUSPECTED OF PATHEMA, THE NUMBER OF EXAMINATIONS, AND THE NUMBER OF LESIONS, WITH LIST OF ERRONEOUS DIAGNOSES

Type of Examination Requested	No. of Such Examinations	No. of Lesions	Clinical Diagnoses Ventured
Lumbar spine	270	3	Low back pain Sprain-strain
Sacroiliacs	46	5	Infection Spondylolisthesis
Lumbosacral junction	230	20	Fracture Arthritis
Routine low back	265	42	Herniation of nucleus pulposus
Total	811	70	

found. For example, the lumbar spine, sacroiliac, and lumbosacral junction studies made consisted of the conventional anteroposterior and lateral views. The sacroiliac views consisted in the main of a single 14 × 17-in. film including the pelvis and hip regions. Obviously these studies are not to be considered exhaustive in any sense of the word. They are barely acceptable. Examinations of this type numbered 546 and yielded only 28 cases, or slightly more than 5 per cent. When, however, x-ray studies ordered for the express purpose of bringing to light an elusive defect were made, the incidence was much higher, namely, 42 positive cases out of a total of 265 studies, or 17 per cent. From this analysis it is interesting to speculate as to how many more positive findings would have resulted had the entire 811 examinations been routine low back studies. Obviously, the question of the accuracy and thoroughness of the method employed in arriving at a diagnosis must have considerable bearing upon the numerator of our statistical fraction.

The mechanics involved in spondylolisthesis will not be considered at this time, as this phase of the subject was previously dealt with. For emphasis, the more obtuse the lumbosacral angle, or the more horizontal the position assumed by the sacrum, the greater the tendency toward slipping in the presence of a bilateral defect. Incidentally, we determine the lumbosacral angle by dropping a vertical line through the centers of the lumbar vertebrae and a similar line through the center of the long axis of the sacrum. At the junction of these two lines the angle is observed, *anteriorly*, not posteriorly. This observation is made because of the confusion created by complicated drawings we have seen purporting to explain how this angle may be calculated.

SYMPTOMS

Curiously enough, the degree of anterior or forward displacement is not always directly proportional to the extent of the symptomatology. Persons with third- and fourth-grade spondylolisthesis may go about their work oblivious of their defective spines, while a person with a prespondylolisthesis or a first-grade spondylolisthesis may have considerable low back pain. This situation is somewhat comparable to the presence of pain in the case of a small osteophyte of a lumbar vertebra and complete absence of pain in a case showing extensive spur formation with bridging.

Subjectively, low back pain is the most common complaint. This varies considerably as to type, intensity, location, and distribution. It may be constant or only actuated by excessive motion or strain at the lumbosacral junction. It may be localized to the back or radiate to the hip or coccyx or show a sciatic type of distribution. Relief in the recumbent position is a common story. Tenderness over the spinous process, with muscle spasm, may be present, but is not usual in cases without a history of recent injury or sudden strong exertion or torsional movement. We have seen little evidence of dorsal root compression, paresthesias, or disturbed reflexes, and one often wonders how this can be in those advanced cases where the inferior articular surface of the fifth lumbar vertebra is compressed against the anterior surface of the first sacral segment and the disk is completely disrupted. There may be limitation of flexion, extension, or lateral motion with or without spasm. Quite recently Gianturco (3) has suggested a method of analysis of the motion factor

of the lower lumbar vertebrae in patients with low back pain. This method may present possibilities for more accurate determination of actual disability. There may be an exaggeration of the lower lumbar curve or a loss of the normal lumbar lordosis.

The clinical picture is obviously vague and unreliable as an aid toward the correct diagnosis. To substantiate this, Table II lists some of the more common clinical diagnoses made. In only 21 of the 811 cases was the clinical diagnosis prespondylolisthesis or spondylolisthesis, and of these only half were confirmed by roentgen examination. It is apparent, therefore, that the diagnosis of these two allied conditions rests with the radiologist.

DIAGNOSIS

We have stated elsewhere and repeat that a thorough knowledge of the anatomy of the lumbosacral area is essential. One can almost, but not quite, master this phase of the subject by reading about it. A far better method is to acquire an articulated pelvis and lumbar spine. Using this as a model, radiographs should be made in the following projections: anteroposterior, anteroposterior with the central ray directed 35 degrees cephalad, right and left oblique, and lateral. In all of these studies the fifth lumbar vertebra and the first sacral segment should receive the central ray. If there is any doubt as to the proper identification of superimposed parts, the process should be repeated with the use of lead numbers to identify the parts in question. After this has been done to satisfaction, the defect may be simulated by cutting or sawing through the isthmus on one side. This cut should traverse the long axis of the isthmus so that the medial portion will be slightly more cephalad than the lateral end. The above described views should then be repeated so that one may become thoroughly familiar with the appearance of a unilateral prespondylolisthesis, for this is the lesion that has been created. To reproduce a bilateral prespondylolisthesis a similar cut should be made in the same region on the sound side and the views should again be repeated. True, this is a laborious procedure but well worth the trouble, as the radiographic interpretation of lumbosacral lesions is not easy at best. Frequent and variable congenital anomalies in this area add to the difficulty.

Time and considerably more material than the 15 cases which formed the basis for our original report (1) have convinced us of the soundness of the roentgen criteria based on the demonstration of the defect by the use of six views. These are as above described, plus a lateral view taken with the patient erect. This view is of no particular value other than to demonstrate the increase in the lumbosacral angle incidental to the erect position. It is sometimes a graphic demonstration of how little actual support the inferior surface of the fifth lumbar vertebra derives from the superior surface of the first sacral segment. The less the support, the greater the shearing forces exerted at this junction and the greater the call made upon surrounding muscular and ligamentous structures for aid in support.

The straight anteroposterior view may or may not demonstrate the defect. We have made the statement elsewhere that more of these lesions could be detected if the defect were searched for in radiographs of the abdomen taken for other reasons than a spine study. In these films a scrutiny of the region immediately below the pedicles will occasionally be rewarded by a suggestive defect zone. This is not always the case, for sometimes, even after finding the defect in the more revealing views, we have returned to the anteroposterior view and still have not been able to demonstrate it to our satisfaction. The usual explanation for this is the excessive superimposition of osseous structures commonly seen in the region of the fifth lumbar vertebra and the first sacral segment.

Often, when the defect could not be seen in the anteroposterior view, the angle anteroposterior view has been of great value. Here, by virtue of distorting or ex-

aggerating the length of the inferior articular processes, we have been able to see more of them as it were, and so find the defect. It may be said, therefore, that the conventional anteroposterior and the angle anteroposterior views (35-degree tilt cephalad of central ray) more or less complement each other.

Occasionally the zone of linear translucency which represents the osseous defect may be transversely directed, and in some instances the medial end of the line may be lower than the lateral end. This is somewhat difficult to explain, for it will be noted that the isthmic area is directed upward, medially, and anteriorly in its upper portion, and downward, laterally, and posteriorly in its lower or more dependent portion. The defect line must of necessity be directed the same way, for it will be noted that the pars interarticularis of the fifth lumbar vertebra is compressed as compared to the same area of higher vertebrae, and if the lamina is to be avoided the medial end of the defect line is almost always forced to lie more cephalad than the lateral end. In those instances in which the medial end of the defect line appears to lie lower than the lateral end we feel that the vertical diameter of the isthmus is greater than usual. It thus becomes possible for the defect to lie high enough so that the medial end may be slightly lower than the lateral portion of the defect and still clear the lamina. An apparent paradox is occasionally seen in which the conventional anteroposterior view will definitely indicate this to be the case and yet the angle anteroposterior view will reveal that the medial end of the defect is slightly higher than the lateral end. This angle anteroposterior view is also of great value in differentiating the medial end of the defect line from the medial side of the apophyseal joint space. The medialmost portion of the defect line never dips downward, whereas the same area of the joint space always shows a caudad inclination. In short, the angle anteroposterior view is of great help because, by virtue of projection, it serves to separate structures which are superimposed in the conventional anteroposterior view. In addition, the true width and appearance of the joint space between the fifth lumbar vertebra and the first sacral segment are revealed.

The oblique studies are probably the most valuable of all, since they serve to separate the isthmus from most other structures. We have used the expression "bow-tie" to describe this crucial zone. The upper portion of the tie consists of the superior articular process and the base of the transverse process slightly below and anteriorly; the lower portion consists of the inferior articular process and the lamina posterior to it. The osseous zone between these structures is constricted and represents the isthmic area or pars interarticularis. The entire structure, as described above, resembles a bow tie lying in an oblique plane. The bow ties of the upper lumbar vertebrae stand out more conspicuously than those of the lower lumbar vertebrae. The former are also seen to lie nearer the vertical plane or on end, while those of the lower levels lie obliquely at about a 30- to 45-degree angle. While still not too familiar with the appearance of these bow ties, a good plan is to study those of the higher lumbar vertebrae, which stand out more clearly, then allow the eye to drop down along the others until the area of the fourth and fifth lumbar vertebrae is reached. By this time one has a good impression of them individually and comparatively so that a defect will stand out more clearly if it is present.

A common pitfall is to measure mentally the difference in densities between the inferior curve of the base of the transverse process seen on end and the isthmic area immediately below. The latter will appear to be less dense. This effect is further heightened by the greater density of the next zone as one goes on to inspect the inferior articular process. The impression may be gained that one is observing a defect. Such is not the case.

The defect line seen in the oblique views may appear as a distinct linear translucency across the isthmus, or there may be

various modifications of this appearance. The defect may be irregular and ill defined. More commonly its edges are eburnated, even though they may be irregular. Sclerotic areas or islands may be present in the isthmic zone with no clear-cut defect line. The isthmus is superimposed upon the upper portion of the body of the vertebra of which it is a part. This is certainly true with respect to the oblique view of the fifth lumbar vertebra; so that bone trabeculae will be seen in the isthmic area whether or not there is a defect. An obvious defect, however, will always show a localized osseous dehiscence. One way to confirm this impression is to follow the line made by the superior border or edge of the superior articular process of the fifth lumbar vertebra. This will proceed downward and posteriorly and should run continuously into the superior border or edge of the lamina. If there is an interruption at the isthmic area, a defect should be suspected. Similarly, the line of the articular surface of the inferior articular process of the fifth lumbar vertebra may be followed, in this case upward and anteriorly. If, once again, an interruption is noted at the isthmic area, a defect is probably present.

Another landmark is the summit of the superior articular process of the first sacral segment. The defect always lies a few millimeters above this point. Occasionally it will be slightly anterior, but most often lies directly above it. Quite often the superior articular process of the first sacral segment may actually appear to be jammed into the defect space or zone, thus partially hiding it. Even the inferior articular process of the vertebra above the level involved may seem to press its inferior tip into the defect site.

It must also be remembered that in obtaining an oblique view the correct degree of obliquity is important, for over- or under-rotation of 5 or 10 degrees may be sufficient to distort the bow-tie shadow and prevent visualization of the apophyseal joint spaces. In a certain number of cases, however, due to asymmetry of the joint planes, a rotation of 35 degrees on one side may reveal the joint space while a similar rotation on the other side may fail to do so. In this case, repeat films with varying degrees of rotation must be done on the side in question before narrowing or obliteration of the joint space can be inferred.

This may be a good place to state, if the impression has not already been gathered, that roentgenographic study of the lumbosacral area is a painstaking procedure, and the amount of information gleaned from the films is often directly proportional to the thoroughness with which the study is conducted. Incidentally, the sacroiliac synchondroses may also be studied, as the joint space of the contralateral side is demonstrable, *i.e.*, the right sacroiliac joint space is neatly seen in the left oblique view of the fifth lumbar vertebra.

The lateral view is of course of irrefutable significance in cases of spondylolisthesis. Here the vertebra involved will show some degree of anterior or forward slipping. In such cases this view alone is sufficient for the diagnosis. The defect line is always found just below and behind the lower posterior inferior angle of the superimposed pedicles. It may be broad, measuring several millimeters, or may be quite narrow. The broader bands of osseous dehiscence or translucency zones are usually seen in the more advanced degrees of forward slipping. The defect line may be horizontal or, as is more often the case, slightly oblique, with its posterior portion higher than the anterior. It is extremely important that the central ray traverse the defect squarely in the same plane, or it will not be adequately demonstrated. Therefore, the defect area should be positioned as nearly as possible over the center of the film and the central ray directed to the same region. The patient must be accurately positioned if confusion and contro versy are to be avoided in the viewing room. The defect line may be straight and well defined or curved. If the latter is the case, the convexity of the curve is directed cephalad. The defect may be so ill defined as merely to give the impression of a gap in the osseous structures at the point in

question. This is particularly true when there has been a slight movement of the patient or if the view is not quite a true lateral. The use of the rotating anode tube is most desirable in the study of the lumbosacral area, certainly with respect to the lateral view. "Spotting" with fully extended cone offers material advantage in the technical quality of the films thus obtained.

A review of the entire series of cases strikingly illustrates the necessity for *complete* study in every instance of a suspected defect, for, strangely enough, one can never foretell which view may reveal the defect to best advantage. In some cases the angle anteroposterior view, in others the oblique views, and often the lateral view may be the most satisfactory. We have not seen one case in which the defect, if present, could not be noted in at least one or more of the six views utilized. So firmly convinced are we of the necessity for each view that we would not want to give a final opinion without the benefit of a complete low back study.

We have noted in several cases of spondylolisthesis that the superior articular processes of the first sacral segment are shorter or more flattened than is usually the case. A possible explanation is that this represents a developmental deficiency of these processes. In any event, the fact that they are so blunt may be a factor in the ease with which the fifth lumbar vertebra slips forward, since their usual buttress effect is decreased by virtue of their limited height. This shortening of the superior articular processes of the first sacral segment is often best noted in the angle anteroposterior view and occasionally in the lateral view, in which these structures, appropriately called "dog ears," seem very small indeed. Suffice it to say that this observation has been made often enough to offer it as a prognostic sign. When the superior articular processes of the first sacral segment are very short in a case of bilateral prespondylolisthesis, one may definitely anticipate forward slipping much sooner than would otherwise be the case. Narrowing of the intervertebral disk occurs late in spondylolisthesis. It is more apt to be seen in those cases which have gone on to a second and greater degree of slipping.

Study of the lumbosacral junction with particular reference to the occurrence of "reverse spondylolisthesis" leads us to doubt the existence of this entity. We originally were of the opinion that we had several cases illustrating this condition, but have since had reason to revise this concept. Normally, one will find that the posterior surface of the fifth lumbar vertebra may at times lie as much as 2 or 3 mm. posterior to the posterior surface of the sacrum. The incidence of this finding is approximately 1.5 per cent in our series of lateral lumbosacral films. We have come to consider it a normal variation. To produce a true reverse spondylolisthesis there must be a defect in the posterior neural arch somewhere between the inferior articular processes and the attachment of the pedicles to the body of the vertebra, or one should be able to demonstrate some widening of the apophyseal joint spaces. In short, it is an anatomical impossibility for a true posterior displacement of a vertebra to occur without some derangement of the posterior neural arch resulting. We have never been able to demonstrate such a derangement in our suspected cases.

SUMMARY

Attention is once more directed to the greater prevalence of prespondylolisthesis and spondylolisthesis than is ordinarily anticipated. The clinical and medicolegal significance of the successful demonstration of either of these conditions should be obvious. It is strongly recommended that a *complete* radiographic study be made in all patients with low back complaints. This should include at least five of the six views recommended and the films must be of good technical quality. The necessity for insistence upon such thoroughness is substantiated by a comparison of the number of positive findings when the complete study is done with the number of

similar findings when only the conventional two views are taken. Furthermore, since the clinical diagnosis, when ventured, is little better than one of many possibilities, the final diagnosis rests with the radiologist. In view of all this, we have been prompted to reanalyze our series in the hope that the radiologist's acumen along these lines may be sharpened. Some details revealed by the various views have therefore been presented.

REFERENCES

1. GALLUCCIO, A. C.: Spondylolisthesis: A General Consideration with Emphasis on Radiologic Aspects. Radiology **42:** 143–158, February 1944.
2. HITCHCOCK, H. H.: Spondylolisthesis: Observations on Its Development, Progression and Genesis. J. Bone & Joint Surg. **22:** 1–16, January 1940.
3. GIANTURCO, C.: A Roentgen Analysis of the Motion of the Lower Lumbar Vertebrae in Normal Individuals and in Patients with Low Back Pain. Am. J. Roentgenol. **52:** 261–268, September 1944.

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Energy Absorption in the Trunk in the Radium Treatment of Breast Cancer by Interstitial and Surface Applicator Methods[1]

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FOLLOWING THE original work of Grimmett (5, 6), Mayneord (13), and Happey (7, 8), a considerable number of papers have appeared dealing with both the physical and clinical aspects of the total energy absorbed throughout the body during roentgen-ray and radium treatment (3, 9, 14, 15, 16, 18). As Ellis (3) has remarked, knowledge of the total energy absorbed (*i.e.*, volume dose or integral dose) may be useful in several ways, namely:

"(1) To compare the total energy absorption for various radiation techniques in individual cases with a view to choosing one technique in preference to another. . . . .

"(2) To decide what is the threshold constitutional dose which should not be exceeded by any technique.

"(3) To provide fundamental data relating the biological effects to the total energy absorption."

In order that this knowledge be available in such a form that it may have these uses, detailed investigations of integral dose for the various techniques of radiation therapy are necessary. Some data of this kind have been reported (3, 14, 18) for some roentgen-ray techniques, for teleradium therapy of the larynx, pharynx, floor of the mouth, and tongue (1), and for treatment of the oesophagus by a radium bougie (12). Bush (1), indeed, was able to relate the integral dose to the proportion of lymphocytes found to survive when regular blood counts were made throughout the treatment.

The recent work of Mayneord (16) on the mathematical theory of integral dose in radium therapy has indicated the methods which may be adopted in order to calculate integral doses for the various techniques of radium therapy other than beam therapy. Being considerably interested in the energy absorbed in the treatment of breast cancer by interstitial and surface applicator radium techniques, we have used the methods suggested by Mayneord to calculate integral dose in the trunk for conditions which seem appropriate to these techniques. Further, we have attempted to relate some published data (4) on the reaction of the lymphocytes during interstitial radium therapy to the integral dose received by the trunk. The purpose of this paper is to present the results of these calculations.

PHYSICAL BASIS OF CALCULATIONS

The real energy conversion when a dose of 1 roentgen is delivered to 1 gram of air is a convenient first approximation to energy absorption in soft tissues, and this quantity is referred to as a gram-roentgen (13). If dose is integrated throughout a given volume or mass, the energy absorbed will be determined in gram-roentgens; this quantity is referred to as the integral dose or volume dose. For clinical use, the gram-roentgen proves to be rather small and the megagram-roentgen (one million gram-roentgens) is rather more convenient. A megagram-roentgen is approximately equivalent to 2 gram calories (13).

In order to keep the calculations within reasonable bounds of simplicity, we have followed Mayneord (16) and assumed the trunk to be a circular cylinder of radius 13.5 cm. This value makes the area of cross section equal to that of an ellipse of semi-axes 10 and 18 cm., respectively. The ellipse would be a closer approximation to the true shape of the trunk but would render the calculations extremely difficult, and the results, when obtained, would not be so generally useful. From calculations made more rigorously for a special case (12), it appears that the errors

[1] Accepted for publication in April 1945.

due to this simplification are not large. We have also assumed the trunk to have an average length of 60 cm.

In the techniques we shall consider, it would seem that the integral dose in the trunk may not be very different from that for the whole body. The integral dose in the head and neck will not be very great because of their small volume relative to that of the trunk. The lower limbs have a considerable volume but will not add much to the integral dose because of their distance from the radium. It is likely that the integral dose in the arms forms a considerable proportion of the total because of their proximity to the radium, but because of their indefinite position it is difficult to allow for this. In view of the kind of general reaction of the patient to integral dose in which one is interested, it seems likely that the integral dose in the trunk is the most important.

Consider a point source of radium filtered by a spherical shell of platinum 0.5 mm. thick, situated at a point P at a distance of b cm. from the axis of a cylinder of length l and radius a cm. (Fig. 1).

The integral dose $d\Sigma$ in the disc element of thickness dx is (16):

$$d\Sigma = 8.3\pi \times \log_e \frac{a^2 - b^2 + x^2 + \sqrt{(a^2 - b^2 + x^2)^2 + 4b^2x^2}}{2x^2} \cdot dx \qquad (1)$$

and by graphical integration of this expression the integral dose may be calculated for the complete cylinder for any position of the radium.

If b is on the axis, so that $b = 0$, the relation reduces to

$$d\Sigma = 8.3\pi \cdot \log_e \left(1 + \frac{a^2}{x^2}\right) \cdot dx \qquad (2)$$

and if $d = 0$ (*i.e.*, P is at the end of the cylinder), the integral dose for the whole cylinder is

$$\Sigma = 8.3\pi \left[l \cdot \log_e \left(1 + \frac{a^2}{l^2}\right) + 2a \tan^{-1}\left(\frac{l}{a}\right) \right] \qquad (3)$$

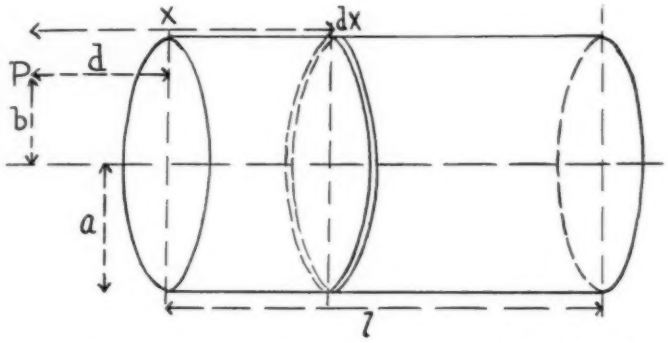

Fig. 1. *P*. Point source of radium b cm. from axis of cylinder l cm. long and a cm. radius.

Calculations made by these formulae yield estimates which are probably too high, because no allowance is made for absorption of radiation by the tissues (and also, possibly, by reason of screening of one source by another in actual practice of the interstitial method). In general, however, the absorption is relatively small.

RESULTS OF CALCULATIONS

Using the above formulae we have calculated the integral dose in the specified cylinder for a variety of positions of P. The results are summarised in Figures 2A and 2B.

Fig. 2 A, shows, for various values of b, the variation of integral dose (in gram-roentgens per mg. hour) with distance from the end of the cylinder, measured toward the centre of the cylinder. Since

the half-length of the cylinder is 30 cm., the curves provide the data for radium at any position along the whole length of the cylinder. A curve is given for radium situated on the cylinder axis and also for a number of values of b such that the radium is 10, 12.5, 13.5, 14.5, 15.5, 16.5, and 17.5 cm., respectively, from the axis. When b = 13.5 cm., the curve corresponds to radium on the surface of the cylinder; b = 17.5 cm., corresponds to radium distributed on a surface applicator having 4-cm. radium-skin distance, and so on. From these graphs, interpolating when necessary, it is possible to determine the integral dose in the trunk due to radium situated at any position along its length.

Fig. 2B gives similar data when P is beyond the cylinder, that is when d has values from 0 to 30 cm.; to avoid confusion fewer values of b are shown. It may be seen how rapidly the integral dose in the trunk falls off as the radium is removed from the trunk. As the distance d approaches 30 cm. or more, the value of b has little effect on the integral dose value, which is to be expected.

It is interesting, as a side issue, to use Fig. 2B in order to compare the integral dose due to absorption in the trunk with that due to the more local absorption in the treatment of a site located in the head. Thus, in the local irradiation of a lip, Mayneord (16) estimates that the integral dose in the head is approximately 445 gram-roentgens per mg. hr. Assuming the lip to correspond to values of b = 8 cm. and d = 10 cm., approximately, we see that the corresponding integral dose in the trunk would be of the order of 300

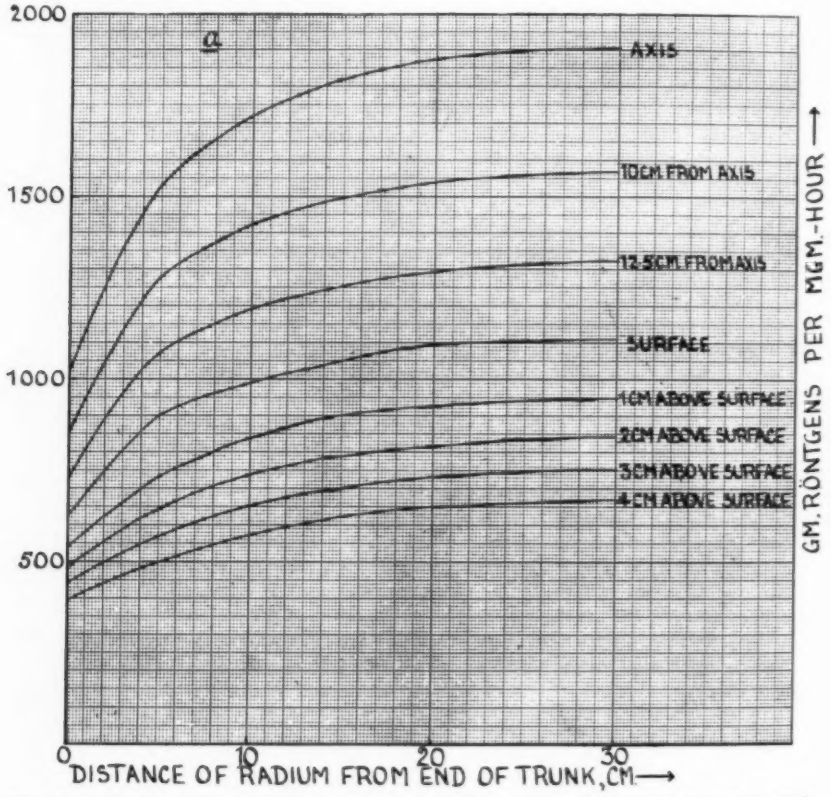

Fig. 2A. Variation of integral dose per mg. hr. with positions of radium along the trunk.

gram-roentgens per mg. hr. That is, the integral dose in the trunk, in this case, is a considerable fraction of the total.

APPLICATION OF RESULTS TO PRACTICAL DISTRIBUTIONS OF RADIUM

In actual practice the radium applied to the breast will not be a single source, nor will the sources be closely concentrated. Common practice shows that in both interstitial and surface irradiation of the breast (2, 10, 11) the radium is usually widely distributed over a large area including the mediastinum, axilla, and supraclavicular region in addition to the breast itself.

It can be shown, however, that if the radium is distributed uniformly, one may assume, to a close approximation, that the whole of the radium is concentrated at the centre of the distribution and so may deduce the integral dose from Fig. 2A for this position. The errors due to this approximation are greatest when the radium extends to the end of the trunk and when the radium covers a considerable area, but even for an area as great as 300 sq. cm. they do not amount to more than 5 per cent (in excess of the true average value). The errors become much smaller as the radium is distributed nearer the centre of the trunk.

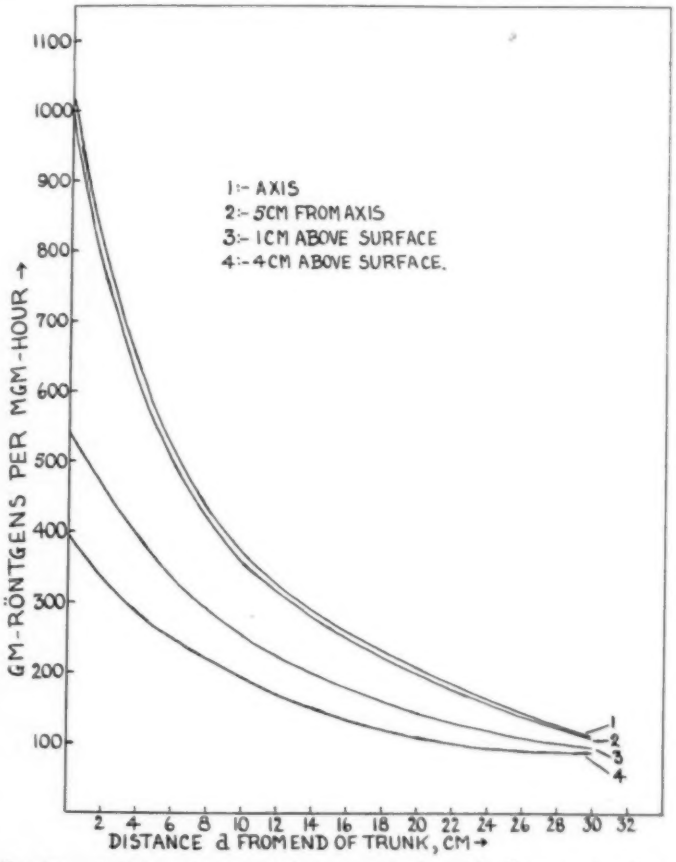

Fig. 2B. Variation of integral dose per mg. hr. with distance of radium beyond the trunk.

In the case of surface applicators on which the radium is distributed according to the Paterson and Parker methods (17), the radium is not uniformly distributed but it is symmetrically balanced and the

distance of the "centre" from the end of the trunk may be determined. It is a close enough approximation to regard all the radium as concentrated at this "centre." In interstitial irradiation the radium may be concentrated in certain regions rather than generally distributed, *e.g.*, in the axilla, the supraclavicular area, and the breast (10). In such cases it would be more accurate to assess the integral dose for each concentration and to add the separate items.

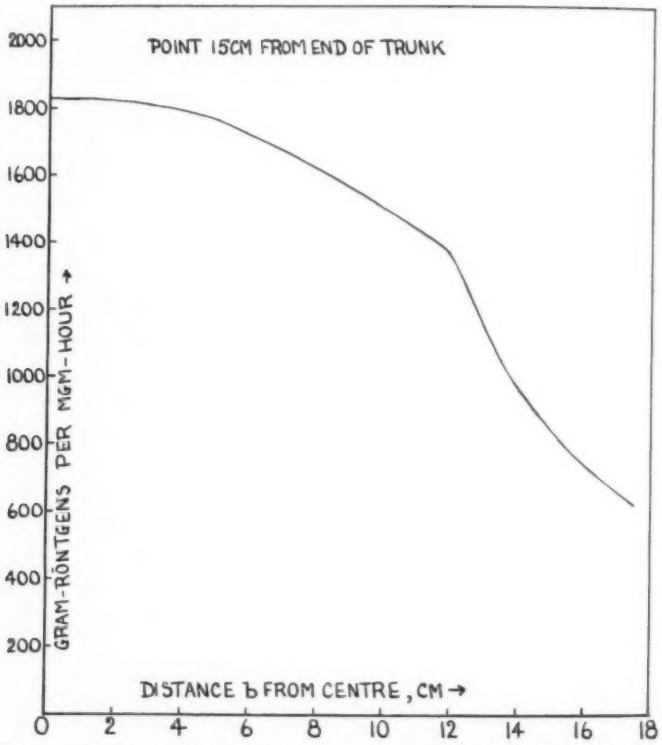

Fig. 3. Variation of integral dose per mg. hr. with distance from the axis of the trunk. Point 15 cm. along the trunk measured from its end.

RELATION BETWEEN TRUNK INTEGRAL DOSE, SURFACE DOSE, APPLICATOR AREA, AND RADIUM-SKIN DISTANCE IN THE SURFACE METHOD OF IRRADIATION

We have thought it of interest to examine how the integral dose in the trunk due to radium surface irradiation will depend upon the area of the applicator and the radium-skin distance, and how it is related to the surface dose due to the applicator. For this purpose, in order to standardise the position of the applicator relative to the trunk, we have considered the centre of the applicator to lie, in each case, at 15 cm. from the end. From the position of the sites usually irradiated in cancer of the breast, this value seemed reasonable. The relation between integral dose per mg. hr. and b for this distance may be deduced from Figure 2A and is shown in Figure 3.

Assuming also that the Paterson and Parker methods (17) are used for the distribution of the radium on the applicator, we may deduce a set of curves which express the relation between the integral dose per 1,000 r delivered to the

surface by the applicator and the area of the applicator, for various values of the radium-skin distance h. These are shown in Figure 4 for h values of 0.5, 1.0, 2.0, 3.0, and 4.0 cm., respectively.

It is seen from Figure 4 that if a surface dose is given of the usual magnitude (5,000–6,000 r) over a large area (say 200 sq. cm.), using, say, 4 cm. radium-skin distance, the integral dose is of the order of 25–30 megagram-roentgens, which is quite large. For larger areas the integral dose is even greater.

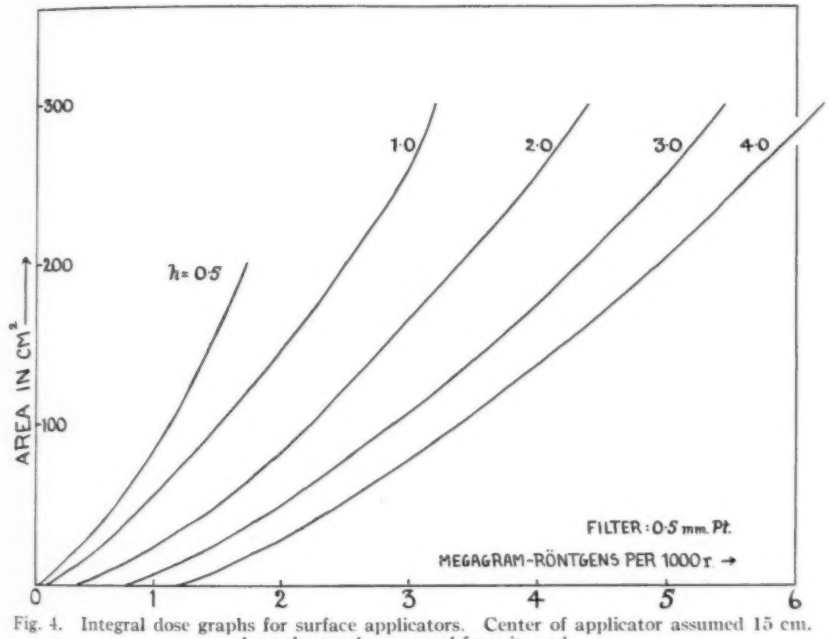

Fig. 4. Integral dose graphs for surface applicators. Center of applicator assumed 15 cm. along the trunk measured from its end.

If, in actual practice, it happens that the centre of the radium distribution is not at 15 cm. from the end of the trunk, the curves of Figure 4 may still be used if a correction is applied by reference to Figure 2A. Suppose, for example, that the centre of a radium applicator of area 200 sq. cm. and h = 3.0 cm. is 10 cm. from the end of the trunk. The corresponding integral dose is found as follows:

From Figure 4, 4.35 megagram-roentgens is the integral dose for 1,000 r.

From Figure 2A the integral dose 10 cm. from the end of the trunk = 735 gram-roentgens per mg. hr. and integral dose 15 cm. from end of trunk = 785 gram-roentgens per mg. hr.

Megagram-roentgens per 1,000 r at a point 10 cm. from the end of the trunk $= \frac{735}{785} \times 4.35 = 4.07$.

ATTEMPTED CORRELATION BETWEEN INTEGRAL DOSE AND CLINICAL EFFECTS IN INTERSTITIAL IRRADIATION OF THE BREAST

Goodfellow (4) made careful periodic blood counts on a series of 26 patients treated for carcinoma of the breast by interstitial radium, the time of irradiation being seven to eight days. In 21 of these cases the information is such that, by making certain approximating assumptions, it was possible to correlate the reaction of the blood and the integral dose.

As above, we have assumed that the "centre" of the radium distribution was 15 cm. from the end of the trunk in each case. The average depth of implantation

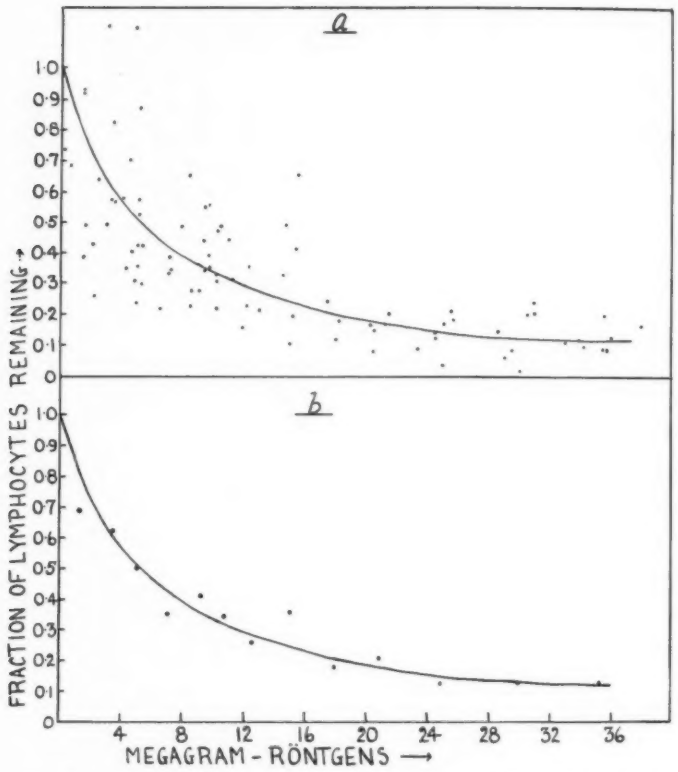

Fig. 5. *a*. Dot diagram showing correlation between integral dose in the trunk and the fraction of lymphocytes remaining. *b*. The data of *a* expressed in terms of the mean values obtained by grouping the dots.

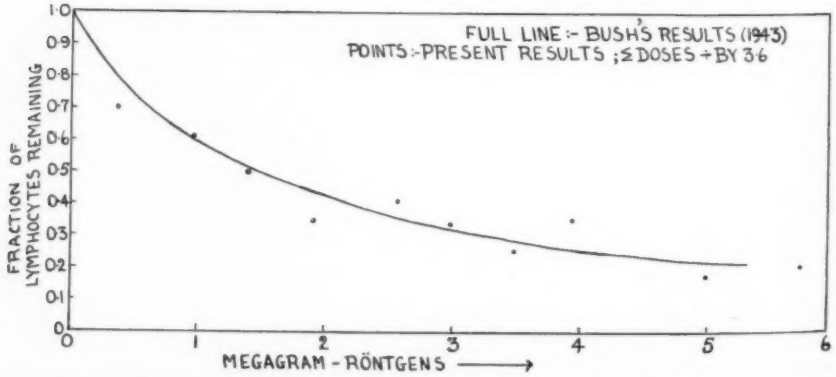

Fig. 6. Comparison of Bush's results (1) with those of Figure 5, *b*.

was given by Goodfellow, so that the average distance from the axis of the trunk was known. With these facts, the integral dose in the trunk may be calculated from the data already discussed. The values so obtained may deviate no doubt from the exact values which would be obtained from a more detailed study of each case individually, but it is hardly likely that the deviations will be so great as those found in the blood counts.

Goodfellow (4) and Bush (1) have both chosen the lymphocyte count as being the most satisfactory index of radiation effect, since it gives the most constant change and is least affected by factors such as sepsis. We have therefore expressed Goodfellow's lymphocyte counts, made throughout treatment, as a fraction of the original pre-irradiation count in each case. The integral dose corresponding to every surviving fraction of lymphocytes was calculated, and the results are shown in Figure 5, *a*, as a dot diagram.

The diagram indicates a regular behaviour, although the points are widely scattered.[2] The behaviour is more adequately specified in Figure 5, *b*, where the same data have been grouped so that the points represent the mean values for each group.

The relation between the fall of lymphocytes and integral dose appears to be of the same nature as that reported by Bush (1) in a study of patients treated by radium teletherapy for disease at sites in the pharynx, larynx, post-cricoid, tongue, and floor of the mouth. It differs markedly, however, in that the integral doses required to bring about proportionate biological changes are much greater in the present case. Thus Figure 6 shows as a full line the results found by Bush, and the points represent those of Figure 5, *b*, but the integral dose values have been divided by a factor of 3.6.

The differences in integral dose required to produce equivalent effects is no doubt due to at least two factors, namely, (*a*) the difference in the region of the body being irradiated and (*b*) the difference in the dose rates and overall times used for the delivery of the radiation.

That factor *a* is important seems obvious, but it is as well to keep it in mind in attempts to relate integral dose and biological effect. It is for this reason that we have chosen only data pertaining to carcinoma of the breast from the wealth of material given by Goodfellow.

It seems to us that factor *b* is probably the most important. It is well known that dose rate is an important factor influencing biological response and that for very low dose rates radiation is usually much less efficient than for high dose rates.[3] Although the integral doses studied by Bush (1) were delivered in a longer overall time they were delivered, during the actual treatment period, at very much higher average dose-rates than were the integral doses we have considered here. In some of those parts of the trunk most remote from the radium, the dose rate in the present case would be very small indeed.

The results show that it is necessary to pay the strictest attention to those other factors in any assessment of integral dose and its correlative biological effects.

SUMMARY

1. The energy absorption or integral dose in the trunk has been calculated for conditions corresponding to those of interstitial and surface radium therapy of cancer of the breast.

2. Graphs are given relating integral dose in the trunk to surface dose in the surface radium therapy of cancer of the breast. It is assumed that the radium is distributed in accordance with the Paterson and Parker methods.

3. Data concerning integral dose in the trunk during interstitial radium therapy of

[2] Goodfellow (4) showed a similar kind of behaviour, but at that time it was not possible to relate the dosage quantities to as precise a measure of energy absorption as integral dose.

[3] See Symposium on "Dosage-Rate in Radiotherapy" by L. H. Gray, F. Ellis, G. C. Fairchild, and Edith Paterson. Brit. J. Radiol. **17**:327–342, 1944.

carcinoma of the breast is correlated with the reaction of the lymphocytes.

4. It is suggested that site and dose rate are important factors in assessing the clinical importance of integral dose.

ACKNOWLEDGMENT: In conclusion, I wish to acknowledge the financial aid given by the British Empire Cancer Campaign to the department in which this work was done.

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REFERENCES

1. BUSH, F.: Estimation of Energy Absorption During Teleradium Treatment. Brit. J. Radiol. **16:** 109–112, 1943.

2. CADE, S.: Malignant Disease and Its Treatment by Radium. Bristol, John Wright & Sons, 1940, Chapter 21.

3. ELLIS, F.: Volume Dosage in Deep X-Ray Therapy. Brit. J. Radiol. **15:** 174–177, 194–201, 1942.

4. GOODFELLOW, D. R.: Radium and the Human Leucocytes. Acta. radiol. **17:** 1–50, 1936.

5. GRIMMETT, L. G.: Contributions to Radium Therapy. Am. J. Roentgenol. **41:** 432–436, 1939.

6. GRIMMETT, L. G.: In Medical Use of Radium: Summary of Reports from Experimental Research Centres for 1939. Brit. J. Radiol. **14:** 1–10, 1941.

7. HAPPEY, F.: Volume Integration of Dosage for X- and γ-Radiation. Nature **145:** 668, 1940.

8. HAPPEY, F.: Calculation of Energy Absorbed in Irradiated Tissue. Nature **146:** 96, 1940.

9. HAPPEY, F.: Integration of Radiation Dosage and Absorption of Energy in Tissue for X and Gamma Radiation. Brit. J. Radiol. **14:** 235–241, 1941.

10. HUTCHISON, R. G.: Interstitial Radium Treatment of Carcinoma of the Breast: Description of a Radical Technique. Brit. J. Surg. **22:** 465–474, 1935.

11. KEYNES, G.: Radium Treatment of Carcinoma of the Breast. Brit. J. Surg. **19:** 415–480, 1932.

12. LEDERMAN, M., AND CLARKSON, J.: Radium Treatment of Cancer of the Oesophagus. Brit. J. Radiol. **18:** 22–28, 1945.

13. MAYNEORD, W. V.: Energy Absorption. Brit. J. Radiol. **13:** 235–247, 1940.

14. MAYNEORD, W. V., AND CLARKSON, J. R.: Energy Absorption: Integral Dose When the Whole Body Is Irradiated. Brit. J. Radiol. **14:** 151–157, 177–182, 1944.

15. MAYNEORD, W. V.: Energy Absorption: Mathematical Theory of Integral Dose and Its Applications in Practice. Brit. J. Radiol. **17:** 359–367, 1944.

16. MAYNEORD, W. V.: Energy Absorption: Mathematical Theory of Integral Dose in Radium Therapy. Brit. J. Radiol. **18:** 12–19, 1945.

17. PATERSON, R., AND PARKER, H. M.: A Dosage System for Gamma Ray Therapy. Brit. J. Radiol. **7:** 592–632, 1934.

18. SMITHERS, W.: Spatial Distribution of X-Rays and Total Energy Absorption: Consideration of Importance of These Concepts in X-Ray Treatment of Cancer. Brit. J. Radiol. **15:** 50–55, 1942.

Henoch's Purpura: Small Intestinal Changes

Case Report[1]

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A DISEASE IN which there is hemorrhage in the gastro-intestinal tract, frequently associated with skin or joint involvement, has been known as Henoch's purpura, Henoch-Schönlein purpura, anaphylactoid purpura, purpura rheumatica, abdominal purpura, and sometimes as idiopathic purpura. The disease is generally considered to be a non-thrombocytopenic form of purpura, but in some cases in which abdominal symptoms have predominated there has been, also, a thrombocytopenia (1, 3). When the abdominal symptoms are unassociated with purpuric manifestations elsewhere, or when abdominal symptoms precede the skin and joint changes, the diagnosis may be difficult (2). Appendicitis, intestinal obstruction, intussusception, and ileitis are the conditions generally confused (2, 4) with Henoch's purpura, and either intussusception or obstruction may be associated with it as a complication (7, 9). Althausen, Deamer, and Kerr (1) reported 8 cases of Henoch's purpura and abdominal allergy, in 6 of which 9 operations had been done in various hospitals.

In the published reports we have found references to gastro-intestinal x-ray examinations for diagnosis of obstruction and intussusception, but no description or note of any intestinal changes. In view of the pathological process, hemorrhage in the mucosal layer, which would obliterate the normal mucosal folds and in severe cases cause separation of patches of mucosa and ulceration, roentgen examination of the intestinal tract would appear to be a valuable diagnostic aid in doubtful cases.

In the case to be reported here there was the appearance of a marked ulcerative or destructive process in the upper jejunum, with loss of the normal pattern in the greater part of the small intestine; there was hypomotility rather than the hypermotility usually found in acute enteritis; and there was dilatation of the upper jejunum, which, associated with the mucosal changes, suggested a chronic ulcerative condition. Re-examination after three weeks showed great improvement in the intestinal pattern, and at the end of six weeks the intestinal pattern and motility were normal.

It is realized that any conclusions based on a single example may be misleading, but this case is reported as one of purpura showing extensive small intestinal damage and remarkable repair ability on the part of the small intestine.

It is suggested that x-ray studies of the small intestine may differentiate purpura from other conditions in acute abdominal cases when the diagnosis is uncertain.

CASE REPORT

H. C. A., white male, age 20, was admitted May 1, 1943, complaining of cramping abdominal pain, which had its onset three days before admission and had been of sufficient severity to interfere with sleep. For the past two days he had had frequent loose bowel movements; three stools, on the morning of admission, were said to contain bright red blood.

The family history was of no significance. Mother, father, and one sister were all living and well. The patient was born in New York State and had not been in the tropics. He had had no serious illnesses but was subject to frequent head colds. He stated that he had always had a "weak stomach" and that slight injuries, as a fall or a blow, frequently caused vomiting and diarrhea. Attacks similar to the present illness had occurred at intervals during the past eight years, but without blood in vomitus or stools. These attacks lasted two to ten days and subsided without medication. The father stated

[1] The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large. Accepted for publication in April 1945.

Fig. 1. Roentgenogram made May 10, 1943, three and one-half hours after meal of barium suspension in water.

that during them he had occasionally noticed blood in the patient's stools. The latest attack prior to the present one was in March 1943.

The patient appeared well developed. His height was 5 ft. 4 in., weight 150 lb., temperature 100.4° F., pulse 112, respirations 24. The pharynx was moderately reddened, and there was a small amount of mucopurulent exudate on the posterior pharyngeal wall. Physical examination otherwise was essentially negative. There were no skin or joint changes. There was moderate abdominal tenderness, but no distention, no rigidity or spasm, and no palpable mass.

The red cell count was 4,220,000, hemoglobin 90 per cent, white cells 24,950 (lymphocytes 24 per cent, monocytes 1 per cent, band forms 2 per cent, eosinophils 1 per cent, segmented neutrophils 72 per cent). The Kahn test was negative. The stool showed many red blood cells but no ova or parasites. The occult blood reaction was 4 plus. The specific gravity of the urine was 1.023, with no abnormal findings.

Clinical Course: The patient vomited blood several times in the first two days in the hospital and passed several tarry stools. He was given nothing by mouth but received fluids intravenously and blood plasma; also 25 mg. thiamine chloride daily. The day-by-day observations were as follows:

May 6: Roentgen examination of the abdomen showed no evidence of obstruction. The surgical consultant was of the opinion that surgery was not indicated at this time.

May 7: A barium enema study disclosed no abnormality of the colon. A chest film was essentially negative.

May 8: Vomiting had ceased. There was no gross blood in the stools, which were still unformed and frequent. The blood plasma protein was 6.02 per cent, hemoglobin 73 per cent. The Sippy diet was instituted.

May 9: Proctoscopic examination was unsatisfactory on account of a large amount of blood in the rectum.

May 10: A gastro-intestinal x-ray examination was done with plain barium suspension in water. The esophagus and stomach appeared normal; gastric emptying was very slow. Serial films (Figs. 1–3) showed that there was still a small gastric residue nine hours after the barium meal At four and one-half hours barium was in the cecum and at eight hours had reached the rectum. There were marked changes in the small intestine. The first and second parts of the duodenum were relatively normal, but the terminal part appeared irregular, and the first part of the jejunum was dilated, with irregularities of the mucosal outline resembling small diverticula or ulcers. The dilated part of the intestine was about 25 cm. in length; below this level some of the loops were of normal diameter, with others apparently decreased in size, with no normal mucosal pattern visible. The impression was that of a chronic process with dilatation and ulceration of the upper jejunum.

May 13: Hemoglobin was 60 per cent; white blood cell count 12,150 (84 per cent segmented). Stool cultures had been negative for dysentery group bacilli; no acid-fast bacilli were found on frequent examinations. The tests for occult blood were all 4 plus.

May 14: A transfusion of 500 c.c. of whole blood was given. On this date, before transfusion, small purpuric spots were noticed on the thighs, legs, and back.

May 15: The tourniquet test was negative. The blood platelet count was 167,000; leukocyte count 20,300 (82 per cent segmented); bleeding time 4 minutes; clotting time 3 minutes.

May 16: Slight swelling of the ankles.

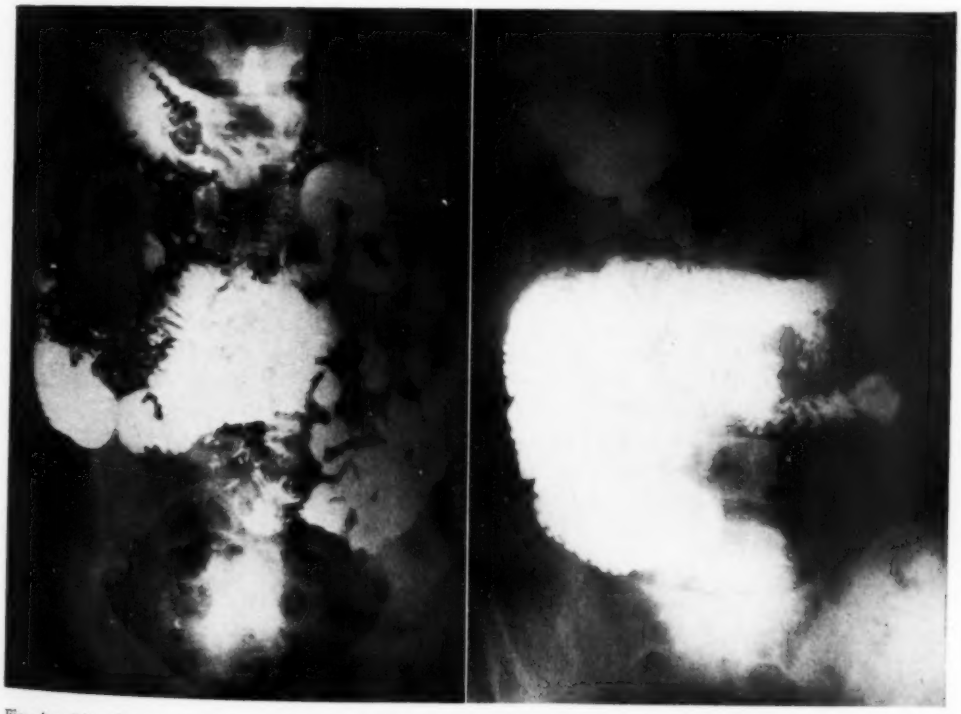
May 17: The tourniquet test was repeated and was negative. Purpuric spots were more prominent. Platelet count 369,750.

May 22: Patient has improved; feels well; purpuric spots fading; swelling of ankles has subsided. Stools are solid and formed. Vomiting has ceased. Weight 138 pounds.

May 27: Blood platelet count 299,000.

June 2: Patient feels well, with no complaints. Stools are normal. Food sensitivity tests are started, 53 food extracts being used.

Figs. 2 and 3. Roentgenograms made May 10, five and one-half hours (left) and nine hours (right) after barium meal.



Figs. 4 and 5. Roentgenograms made June 8, three hours after barium meal (left), and June 29, one hour after meal (right).

June 4: All food sensitivity tests negative except 1 plus reaction for peas and chocolate.

June 8: Gastro-intestinal examination shows marked improvement in small intestine (Fig. 4).

June 29: Re-examination shows practically normal small intestinal pattern (Fig. 5), with normal gastro-intestinal motility.

July 3: Patient has regained lost weight and feels well. He has been surveyed for discharge from the service.

SUMMARY

A young white male had symptoms of acute abdominal disease, with leukocytosis, moderate elevation of temperature, and blood in the vomitus and stools. He gave a history of previous similar attacks, but with no gross hemorrhage. X-ray examination on the tenth hospital day showed marked small intestinal changes. Purpura was not considered until purpuric skin lesions were observed on the fourteenth day in the hospital. Blood platelet counts were not made before the appearance of skin lesions; only one such count was definitely below normal. There was no definite eosinophilia.

It is suggested that x-ray studies of the small intestine may be of diagnostic aid in obscure abdominal cases.

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REFERENCES

1. ALTHAUSEN, T. L., DEAMER, W. C., AND KERR, W. J.: The False "Acute Abdomen"; Henoch's Purpura and Abdominal Allergy. Ann. Surg. **106:** 242–251, 1937.

2. BARNES, C. G., AND DUNCAN, G. W.: Anaphylactoid Purpura Simulating Acute Regional Ileitis. Brit. J. Surg. **29:** 253–255, 1941.

3. BOCKUS, H. L.: Gastro-Enterology. Philadelphia, W. B. Saunders Co., 1943, Vol. I, p. 575.

4. DINKLER, G.: Klinische Verlaufsformen der Purpura rheumatica und Purpura abdominalis (athrombopenische Purpura; hämorrhagische Kapillartoxicose, E. Frank, Morbus Schönlein-Henoch). Deutsche med. Wchnschr. **64:** 523–527, 1938.

5. MINOT, G. R.: In a Textbook of Medicine, edited by R. L. Cecil. Philadelphia, W. B. Saunders Co., 6th ed., 1943.

6. McIVER, M. A.: Acute Intestinal Obstruction. New York, Paul B. Hoeber, 1934.

7. GRAY, T.: Henoch's Purpura Causing Acute Obstruction Twice in Eight Days. Lancet **1:** 841, 1936.

8. HERRMAN, J. B.: Schönlein-Henoch's Purpura Simulating the Acute Surgical Abdomen. Connecticut M. J. **4:** 202–207, 1940.

9. SCHWARTZMAN, J.: Henoch's Purpura with Intussusception. Arch. Pediat. **57:** 389–394, 1940.

Dysgerminoma of the Ovary with Widespread Metastases[1]

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In 1931, Meyer first applied the term "dysgerminoma" to the ovarian counterpart of the testicular seminoma. Although there are approximately 200 cases reported in the literature up to 1939 (1), the dysgerminoma is a relatively uncommon ovarian neoplasm, its frequency being variously reported as 3 to 10 per cent of primary malignant tumors of the ovary (1, 5, 6, 7). It appears typically at an early age, becoming manifest most often in the second to fourth decades, and is characterized by a progressively enlarging pelvic mass which may reach large proportions. When this finding is associated with pseudohermaphroditism or other genital maldevelopment, the diagnosis should be strongly suspected. Novak (5), however, has pointed out that more than one-half of his patients had normal genital development. Various degrees of ascites may be present in about 10 per cent of patients (7).

The tumor is believed to be hormonally indifferent (3, 5), in conformity with Meyer's concept of its origin from "an undifferentiated form of germinal cells which have lost their faculty of becoming either masculine or feminine in type" (4). On the other hand, careful hormone studies have not been carried out in a sufficient number of patients to determine subclinical amounts of hormone production. This has been emphasized by Seegar (7).

The tumor is grossly rubbery or brain-like in consistency, and microscopically is made up of uniform cells separated into groups by fibrous septa which usually contain lymphoid cells. In some specimens there are scattered microscopic granulomatous nodules resembling tubercles. The degree of malignancy cannot be judged from the microscopic appearance and is determined best at operation by the presence or absence of invasion or metastasis.

Fig. 1. Appearance of patient on admission to the hospital.

According to Novak (5), treatment should consist of removal of the involved ovary and adnexa. The opposite ovary should be removed only if involved. Opinion in the literature differs on the incidence of bilateral occurrence: Seegar (7) states that 20 per cent are bilateral, while Dockerty and MacCarty (1) give a higher figure, 35 per cent. The tumor is radiosensitive, and radiotherapy should play an important role in the management of recurrence and metastases (2, 5, 8).

The tendency of the testicular seminoma to widespread and early metastasis is well known. The dysgerminoma of ovarian origin, on the other hand, tends to grow to large dimensions and to invade locally the pelvic structures. Distant metastases are rare and, when they occur, often are confined to the abdominal viscera. Seegar (7) states that in his review of 79 cases reported in the literature and in 19 of his own patients there were only 3 with metastases and these were all within the abdo-

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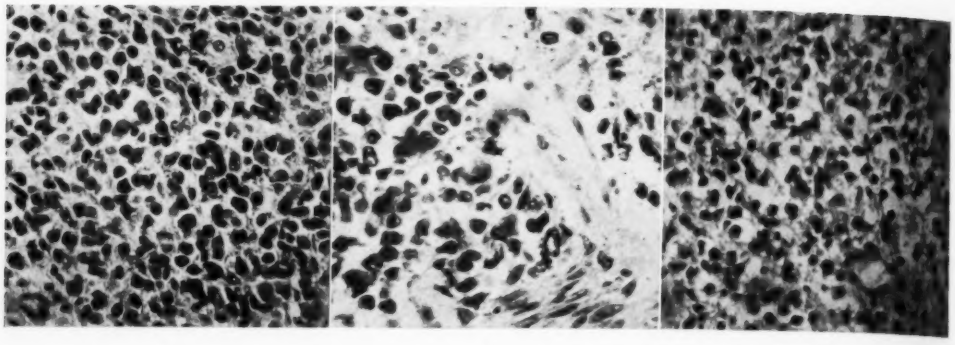

A B C

Fig. 2. Histologic appearance of the dysgerminoma in various sites. A. Orbital tumor, surgical specimen. B. Primary tumor in the ovary, autopsy specimen. C. Metastatic tumor in a lumbar vertebra, autopsy specimen.

men (kidney, pancreas, spleen, and liver).

The overall five-year survival rate as reported by Seegar (7) is 50 per cent.

The patient being presented was considered to be of unusual interest because the first manifestation of dysgerminoma was an *intraorbital mass*, and the primary tumor did not reveal the typical finding of a pelvic mass. Furthermore, the orbit is a relatively infrequent site of metastases in general (8). Finally, there were also metastatic deposits in the skeleton, thymus, and lungs.

CASE REPORT

An 11-year-old white girl was admitted to the ophthalmologic service of Dr. F. H. Adler on June 6, 1942, because of progressive closure of the right eye of one month's duration (Fig. 1). The remainder of the history was essentially negative. The physical examination disclosed a soft, smooth, non-cystic swelling of the right eyelid which had everted the tarsus and conjunctiva. There was no pulsation or bruit. The eyes were straight and the pupillary reactions were normal. The fundi were negative, as was the remainder of the physical examination. The clinical impression was either a sarcoma of the eyelid, an angioma, or an implantation cyst.

On June 10, 1942, an attempt was made to remove the palpebral mass, but excision was incomplete because of the infiltrating character of the lesion. The tumor was grayish-white and friable, and its point of origin could not be definitely determined. The microscopic diagnosis was myxosarcoma (Fig. 2, A).

Following the operation, the residual tumor grew rapidly and radiotherapy was instituted. Twelve radon seeds, 1 millicurie each, filtered by 0.3 mm. gold, were implanted into the mass, delivering approximately 5,000 gamma roentgens. At the end of one month, the lesion had disappeared except for a small zone of induration at the inner canthus.

Three months later, the patient began to complain of pain in the right hip (Fig. 3). Roentgenograms revealed osteolytic lesions widely distributed in the skeleton: skull, head, and neck of both femurs, distal metaphysis of right tibia, proximal metaphysis of left fibula, and the body of the fourth lumbar vertebra (Fig. 4). It is of interest that the metastasis in the left femoral neck became apparent eleven days after a negative roentgenogram. No pulmonary metastases could be demonstrated roentgenologically. A course of 200-kv. roentgen therapy was started because of a pathologic fracture of the right femoral neck, but the patient died suddenly on Oct. 4, 1942.

Necropsy: The examination was limited to the thorax and abdomen by specific permission.

Heart: Focal necrosis of the myocardium; necrotizing endocarditis; auricular mitral vegetation, thrombotic.

Lungs: Edema; metastatic carcinoma.

Spleen: Eosinophilia.

Liver: No metastases found.

Stomach: Aberrant pancreatic tissue.

Adrenals: Normal.

Uterus: Normal.

Ovaries: Moderately enlarged. Both contained circumscribed soft white masses. Microscopically, these were made up of uniform medium-large cells in groups separated by fibrous trabeculae devoid of lymphoid elements. The cytoplasm was scanty. The nuclei were relatively large and contained diffuse chromatin, but no nucleoli. Mitoses were relatively frequent. There was no intercellular reticulin or other specific substance (Fig. 2, B).

Thymus: Normal in size; metastases were present.

Bone: Metastases in all five lumbar vertebrae (Fig. 2, C).

Pathologic Diagnosis: Dysgerminoma of ovaries, with metastases in lungs, thymus, and bones.

Comment: Careful microscopic study of the ovarian tumor and of the various metastatic areas led to the diagnosis of dysgerminoma, and this opinion was shared by several pathologists. Review of the slides of the surgically excised orbital tumor revealed a structure essentially similar to that of the ovarian neoplasm,

Fig. 3. Metastatic involvement of head and neck of right femur.

except for the wider separation of the cellular elements and less distinct fibrous trabeculation. The conclusion was that the orbital lesion was metastatic from the ovarian dysgerminoma.

Fig. 4. Metastatic involvement of fourth lumbar vertebra.

BIBLIOGRAPHY

1. DOCKERTY, M. B., AND MACCARTY, W. C.: Dysgerminoma, with a Report of Nine Cases, One Associated with Pregnancy. Am. J. Obst. & Gynec. **37:** 878–885, 1939.

2. EWING, J.: Neoplastic Diseases. A Treatise on Tumors. Philadelphia, W. B. Saunders Co., 4th Edition, 1940, p. 662.

3. GREENBLATT, R. B., AND PUND, E. R.: Dysgerminoma Ovarii. Am. J. Obst. & Gynec. **35:** 667–675, 1938.

4. MEYER, R.: Pathology of Some Special Ovarian Tumors and Their Relation to Sex Characteristics. Am. J. Obst. & Gynec. **22:** 697–713, 1931.

5. NOVAK, E., AND GRAY, L. A.: Disgerminoma of the Ovary. Clinical and Pathologic Study of 17 Cases. Am. J. Obst. & Gynec. **35:** 925–937, 1938.

6. SAILER, S.: Ovarian Dysgerminoma. Am. J. Cancer **38:** 473–482, 1940.

7. SEEGAR, G. E.: Ovarian Dysgerminoma. Arch. Surg. **37:** 697–725, 1938.

8. WILLIS, R. A.: The Spread of Tumors in the Human Body. London, J. and A. Churchill, 1933, p. 412.

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Accessory Urethral Channel: Case Report[1]

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BECAUSE OF THE uncommon occurrence of an accessory urethral channel, the following case is reported in the radiological literature for the benefit of roentgenologists who may not read the urological periodicals. A more complete report of the same case by Capt. John S. Kessell, M.C., A.U.S., is awaiting publication in an as yet unannounced urological journal. The exact frequency of accessory urethral channels which run the length of the penis but fail to enter the bladder is not known, but Hinman cites McKenzie's report of 31 cases of accessory urethral channels. The length of the accessory channels is not mentioned.

CASE HISTORY

A white male soldier of 27, single, with thirty months of service in the Army, reported to the genito-urinary clinic on Sept. 11, 1943, complaining of a urethral discharge which had begun the morning before. There was no burning on urination. Exposure to infection occurred on Aug. 26, 1943. Sanitube prophylaxis was administered to the usual urethral orifice. Examination revealed a purulent urethral discharge. The urine showed cloudy shreds. A smear revealed Gram-negative intracellular diplococci. Sulfathiazole treatment (1.0 gm. every four hours, total dose, 24 gm.) was given, with the patient remaining on duty status.

When the discharge failed to clear completely, the patient was admitted to the hospital, Sept. 23, 1943, where the accessory sinus in the penis was discovered. The other parts of the examination were essentially the same as in the clinic. The blood count and serology were normal. Another course of sulfathiazole (4.0 gm. in the first dose, and 1.0 gm. every four hours) was given, being discontinued on Oct. 2, 1943. Urethral irrigations were also given, but the discharge continued.

The patient was then transferred to Letterman General Hospital, Oct. 8, 1943. There he received an 8.0-gm. course of sulfadiazine and three mechanical fever treatments (two for eight hours and one for seven hours, between 105 and 106° F., on Oct. 19, 23, and 30, respectively). Three silver nitrate irrigations were also done in the intervals between fever treatments and a No. 24 sound was passed on Nov. 24, 1943. The two-glass urine test, smears, and cultures were negative for *N. gonorrhoeae* soon after the treatments, and the patient was discharged from the hospital to duty status on Dec. 11, 1943.

Fig. 1. Urethrogram in oblique projection, showing the normal urethra filled with opaque material and an opaque catheter lying in the accessory urethral channel which ends at the symphysis pubis.

A urethrogram was then made with opaque material introduced into the normal urethra and an opaque catheter introduced into the sinus above the normal urethra. The accessory channel was found to run the whole length of the penis and to end blindly at the symphysis pubis (Fig. 1). Its diameter was approximately half that of the normal urethra. Its presence was no doubt at least partly responsible for the failure of the prophylactic treatment, since the latter was administered only to the normal opening The accessory channel probably became infected and, due to its proximity, maintained the infection in the normal channel by direct inoculation of organisms.

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REFERENCE

HINMAN, FRANK: Principles and Practice of Urology. Philadelphia, W. B. Saunders Co., 1935, pp. 410–411.

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A New Method of Making Radon Ointment[1]

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IN USING THE Kohn-Richards method of making radon ointment at the Philadelphia General Hospital, certain changes in the method seemed desirable. The Kohn-Richards method consists of agitating lanolin in the presence of radon. This results in a mechanical enclosure of the radon in the form of minute bubbles when the lanolin solidifies. Tests show that when this ointment is exposed to air its radiation intensity falls more rapidly than would be expected from the exponential decay of radon itself. Furthermore, it would seem, from the nature of the method and from tests made, that there is a definite upper limit to the concentration of radon per cubic centimeter of lanolin.

In view of these features, an investigation was undertaken to find an adsorbent substance which could be used to occlude radon to a greater degree and maintain the radiation intensity under atmospheric conditions or, failing in this, to determine what modification could render available substances occlusive.

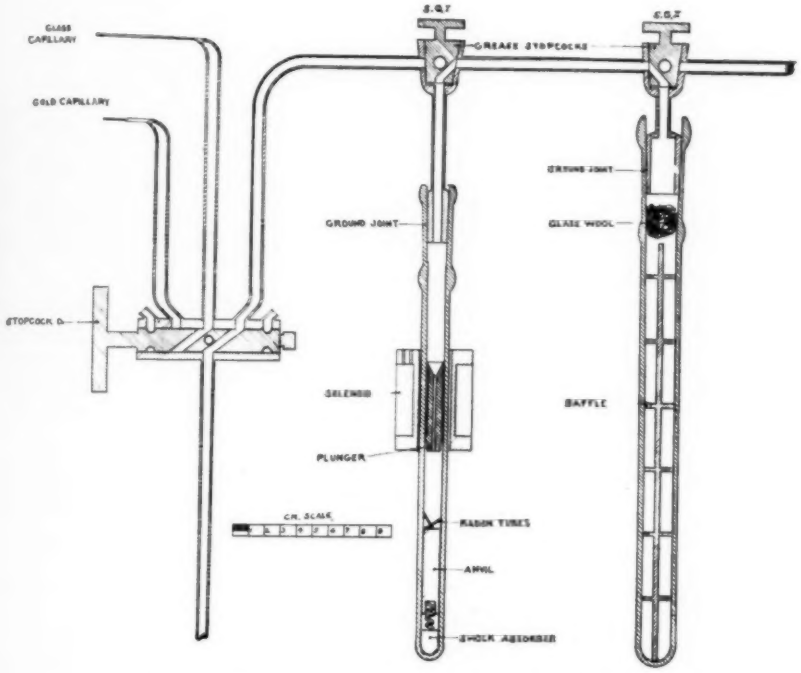

Fig. 1. Apparatus for impregnating charcoal with radon.

The utilization of charcoal for the production and improvement of a vacuum has long been known to physicists. It was therefore considered suitable for this purpose. It was found that when granular charcoal was properly degassed by heating in a vacuum it could thereafter adsorb radon to a high degree. The adsorption of the radon could be made to approach 100 per cent if the degassing was carefully

[1] Accepted for publication in April 1945.

controlled. It was found, however, that the charcoal lost about 80 per cent of the radon in twenty-four hours when exposed to air. That is, the radiation emission of the substance did not follow the law of radon decay but dropped with considerably greater rapidity. This drawback was almost entirely overcome by distributing the substance in liquid petrolatum or any other similar emollient while cooling. The attached stands within the chamber. Each of these disks has a hole drilled in it in such a way that the holes in adjacent disks are 180 degrees displaced from one another. This arrangement constitutes a baffle and aids in preventing the adsorbent from circulating into the remainder of the apparatus while being degassed.

In making the ointment, air is admitted into stopcock *D*, the crusher, and the

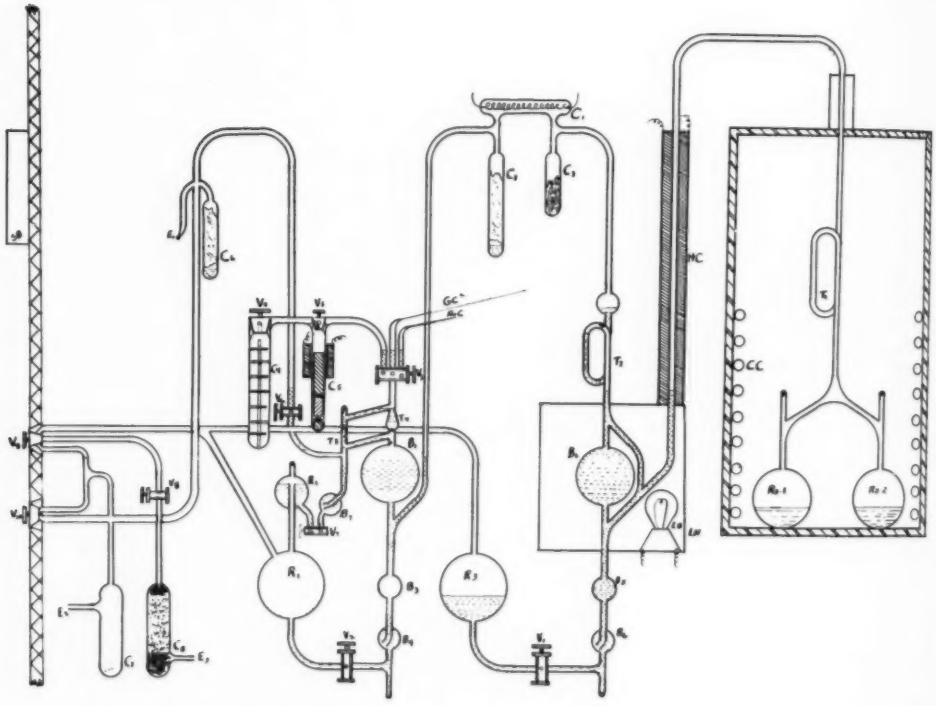

Fig. 2. Failla-Duane radon apparatus to which is attached the apparatus shown in Figure 1.

radiation decay was then approximately that of radon in a sealed container.

A description of the process is as follows: The radon tube crusher developed by the authors is used in conjunction with another pyrex chamber of somewhat similar construction. This chamber and the manner in which it is related to the rest of the apparatus are shown in Figures 1 and 2.

The degassing chamber has a ground tapered joint at its upper end. A brass rod to which a number of brass disks are degassing chamber. The degassing chamber is then removed and some powdered or granular charcoal is placed in the bottom of the chamber. The baffle is inserted and clean glass wool packed over the uppermost baffle. The chamber is then rotated so as to distribute the grease on the ground joint, and clamped in a fixed position. Concentric with the degassing chamber is a pyrex cylinder of larger diameter which is wound with a number of turns of nichrome wire for heating the charcoal. The

sealed radon tubes are then inserted into the crusher. The evacuation of the system is begun. In order to take advantage of the adsorptive properties of the charcoal, it is first necessary to rid it of those gasses which are already adsorbed. On applying heat slowly to prevent excessive agitation of the charcoal and at the same time slowly evacuating the degassing chamber, the initial turbulence due to the outgassing length of time should be allowed for it to expand into the degassing chamber. When this is done, the charcoal is poured into liquid petrolatum and thoroughly stirred. When the ointment cools, it is ready for use.

It was found possible, when using granular charcoal, attapulgus clay, decalso, and alumina, to dispense with the baffle system and simply use a plug of

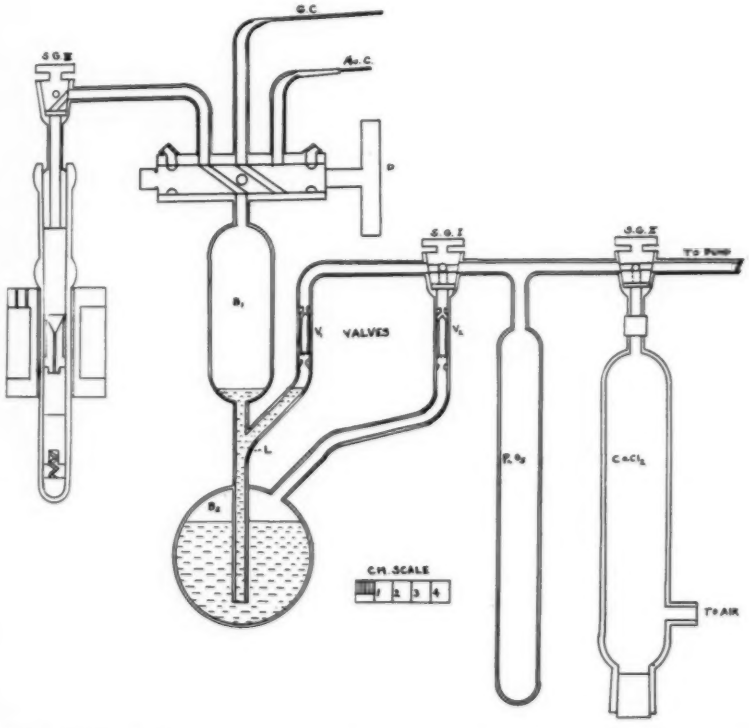

Fig. 3. Apparatus for impregnating charcoal with radon, attached to its own vacuum system.

will subside. The evacuation and heating are continued for half an hour, at the end of which time the charcoal may be considered to be sufficiently degassed. The apparatus is then isolated from the emanation plant to which it is attached, after which the radon tubes are crushed and the radon permitted to diffuse into the charcoal and be adsorbed as the charcoal slowly reaches room temperature. Since radon is a heavy gas and hence diffuses slowly, a reasonable glass wool to prevent diffusion into the remainder of the system during the degassing process. To expedite the degassing of the adsorbents previous to their activation by radon, the nichrome heater was done away with and a torch used to apply heat to the chamber for a five- to fifteen-minute interval while simultaneously evacuating the system. Evidently complete outgassing is not secured in such a short time, but it is generally sufficient

for the purpose. The same procedure as described for the activation of charcoal with radon is followed for other adsorbents.

To facilitate this investigation and other similar ones, the authors devised a compact apparatus requiring an addition of only a mechanical vacuum pump. Thus it was possible to separate entirely the experimental procedure from the radon emanation plant. Figure 3 shows this apparatus.

In conclusion, it may be said that it has been found possible to make radon ointment more conveniently and to achieve a higher millicurie intensity by activating granular charcoal, attapulgus clay, decalso, or alumina with radon and mixing it with an emollient than is possible by the emulsion method.

Midvale Steel Co.
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REFERENCES

DUNOYER AND SMITH: Vacuum Practice. New York, D. Van Nostrand Co.

KOHN-RICHARDS, HANS: Semi-Automatic Vacuum Double Chamber for Absorption of Radon in Fluid Media. Am. J. Roentgenol. **47:** 636–639, 1942.

UHLMANN, ERICH: Treatment of Injuries Produced by Roentgen Rays and Radioactive Substances. Am. J. Roentgenol. **41:** 80–90, 1939.

Protection Measurements of Lead-Shielded Radium[1]

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MOST DATA ON radium protection are based on the absorption coefficients obtained with narrow collimated beams and on the application of the "inverse-square" law. Yet, in the majority of protection problems we are dealing with radiation that is not limited to a small cross section and with conditions where the scattered radiation from neighboring objects contributes considerably to the dose received by the radium workers. In this study we have compared the transmission of gamma radiation through lead for narrow and broad beams. Experiments were arranged also to determine the validity of the "inverse-square" law as applied to radium protection. Finally, a study was made of the protection obtained with lead shields of the type used while handling radium.

APPARATUS AND EXPERIMENTAL PROCEDURE

The characteristics of the three types of ionization chambers used in this investigation are shown in Table I. The spherical chamber, SX-11, was used for all the measurements[2] after preliminary tests had shown that the difference in transmission obtained with the two spherical chambers was within the experimental error. All the chambers had an aluminum rod of 3 mm. diameter as center electrode, while a coating of aquadag on the inside of the wall of the chamber served as the other electrode.

The center electrode of the chamber was charged to 525 volts as measured with a Wulf type electrometer. The chamber was then disconnected and exposed to the radiation for a period of not less than nine minutes. It was then removed from the beam and reconnected to the electrometer, where the voltage drop was observed. The exposures were timed to give a nearly constant voltage drop (about 225 volts), thereby eliminating possible errors due to lack of linearity of the electrometer scale. Correction was made for the natural leakage, which was of the order of 0.05 to 0.1 division per hour.

TABLE I: IONIZATION CHAMBER CHARACTERISTICS

Chamber No.	Shape	Wall Material	Wall Thickness (mm.)	Inside Diameter (cm.)	Inside Length (cm.)	Calculated Volume (c.c.)
SX-10	Spherical	Lucite	3.0	9.5	..	449
SX-11	Spherical	Polystyrene	3.0	10.4	..	588
CX-F4	Cylindrical	Presdwood	3.5	13.6	13.4	1946

The source of radiation was a 305.8-mg. capsule of radium or a radon bulb with an initial value of 400–500 millicuries. Each source had a filtration equivalent to 0.5 mm. Pt.

NARROW BEAM MEASUREMENTS

In Figure 1 is shown the arrangement used in making the lead absorption measurements with a collimated beam. The shield was made up of lead bricks, 2 × 3 × 4 inches, and 8-inch lead squares 1 inch thick, all placed around a center lead casting provided with a conical hole 30 cm. long and with a diameter varying from

[1] From the Physics Laboratory, Department of Hospitals, City of New York. Read by title at the Joint Meeting of The American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

[2] Except for the transmission through 19 cm. of lead, where the dosage rate was extremely low and the large cylindrical chamber was used.

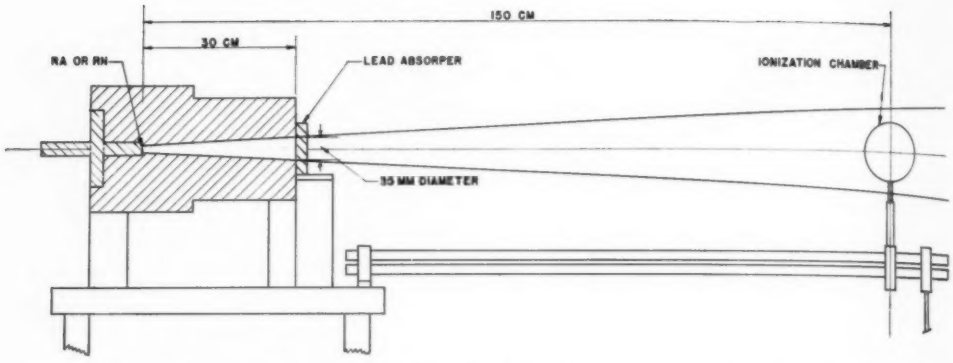

Fig. 1. Schematic drawing showing arrangement used for making narrow beam absorption measurements.

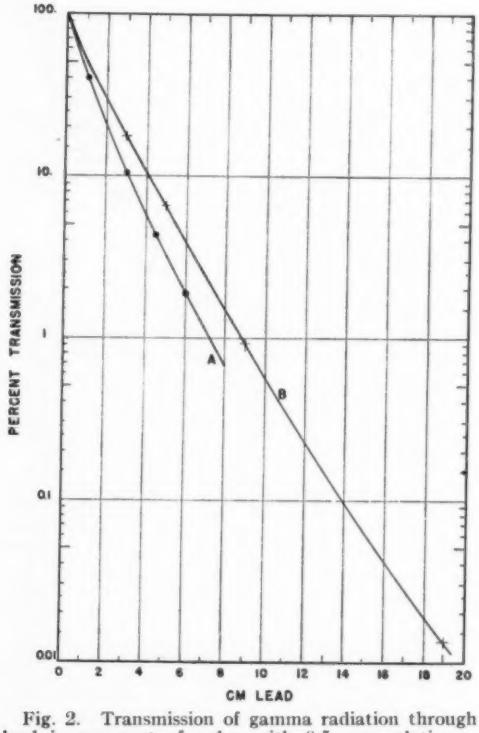

Fig. 2. Transmission of gamma radiation through lead in per cent of value with 0.5 mm. platinum. Curve A. Narrow beam. Curve B. Wide beam.

10 to 35 mm. The radium or radon was located at the end of a removable lead plug provided with a 1-inch lead shield and handle.

The chamber was mounted on an optical bench permitting a range in radium-ionization chamber distance of 150 to 250 cm. The beam was so directed that there was no back-scatter from any object within a distance of 10 meters from the chamber. Lead absorbers of two different sizes were used, sheets or blocks, 7 cm. and 10 cm. square. They were placed in the beam in contact with the shield at the aperture. The thickness of the lead was determined by micrometer readings and by weighing. Both checked within 1 per cent for a density of 11.36. It was found that, for the same thickness, there was no difference in transmission of the 7- and 10-cm.-square lead absorbers. This indicates that the transmission of radiation through the front of the shield was insignificant.

Preliminary measurements were made at different distances to check the "inverse-square" law. The maximum variation from the "inverse-square" law was found to be 1.5 per cent over a range of 150 to 250 cm. in radium-ionization chamber distance. The ratio of the measured to the calculated values increased with the distance. This may be explained by the contribution of scattered radiation.

Curve A, of Figure 2, indicates the percentage transmission obtained with the narrow beam at a radium distance of 150 cm. The 100 per cent refers to the reading obtained without any lead absorber in the beam. This reading was taken between successive absorption measurements, thereby eliminating the need for air density corrections. A comparison of our ab-

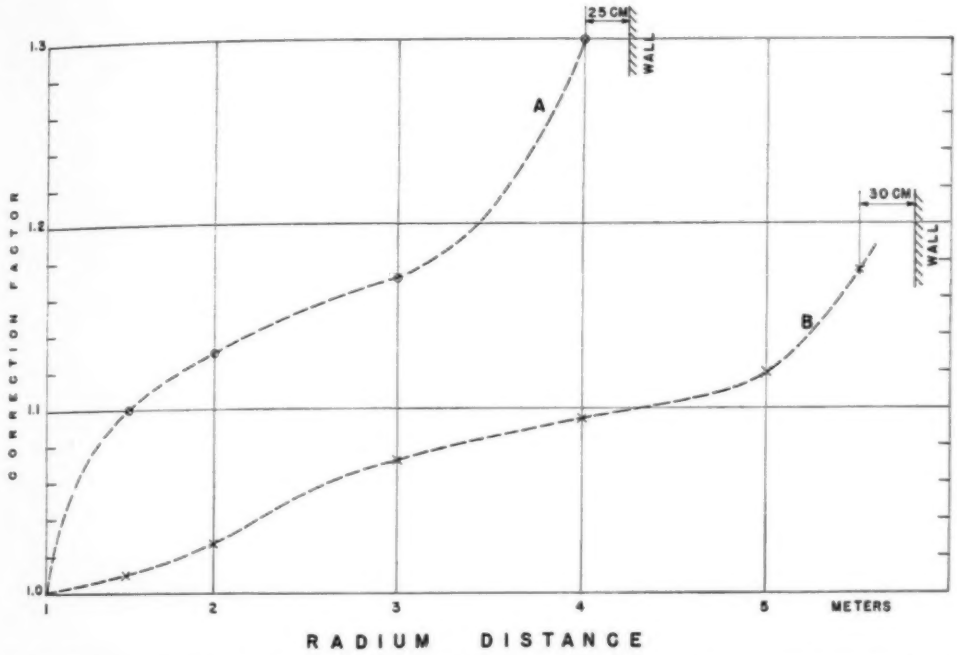

Fig. 3. Distance correction factor for wide beams. The factor indicates the ratio of the measured and calculated dosage rate.

sorption curve with those by Kaye and Binks (1) shows that ours is lower than their experimental and slightly higher than their calculated absorption curves.

WIDE BEAM MEASUREMENTS

Wide beams of radiation were obtained by completely surrounding the radium with lead of increasing thickness. Special cylinders were constructed to fit snugly inside each other and to provide a range in wall thickness from 1 to 19 cm. The smallest cylinder had a bore of 1 cm. to hold the radium capsule or radon bulb. The top and bottom of each cylinder had the same thickness as its wall. The cylindrical shape was chosen to duplicate the type of container commonly used for storing and transporting radium. The measurements were made with the radium located 50 cm. from the wall and at the center of a table with a wooden top 88 cm. above the floor. The ionization chamber was mounted on a tripod with the center of the chamber kept at the level of the radium.[3]

Curve B, of Figure 2, indicates the percentage transmission obtained with the non-collimated beam and with a radium-chamber distance of 150 cm. The 100 per cent refers to the reading obtained with the unshielded radium capsule (filtration equivalent to 0.5 mm. Pt) resting on the table top. This value was found to be 18 per cent higher than that measured with the radium freely suspended in the air.

COMPARISON OF NARROW AND WIDE BEAMS

A comparison of curves A and B indicates that the percentage transmission of the narrow beam falls off much more rapidly than that of the non-collimated beam. For instance, at 6 cm. of lead it is 1.88 per cent against 3.85 per cent, or a ratio of almost 1 to 2. For still greater thicknesses of lead, the ratio becomes even higher. The difference in slope of the two curves

[3] Except for the lower filtrations, where it was slightly higher so that the bottom of the chamber always was above the table. This was done to prevent absorption by the table top, which would reduced the radiation reaching the ionization chamber.

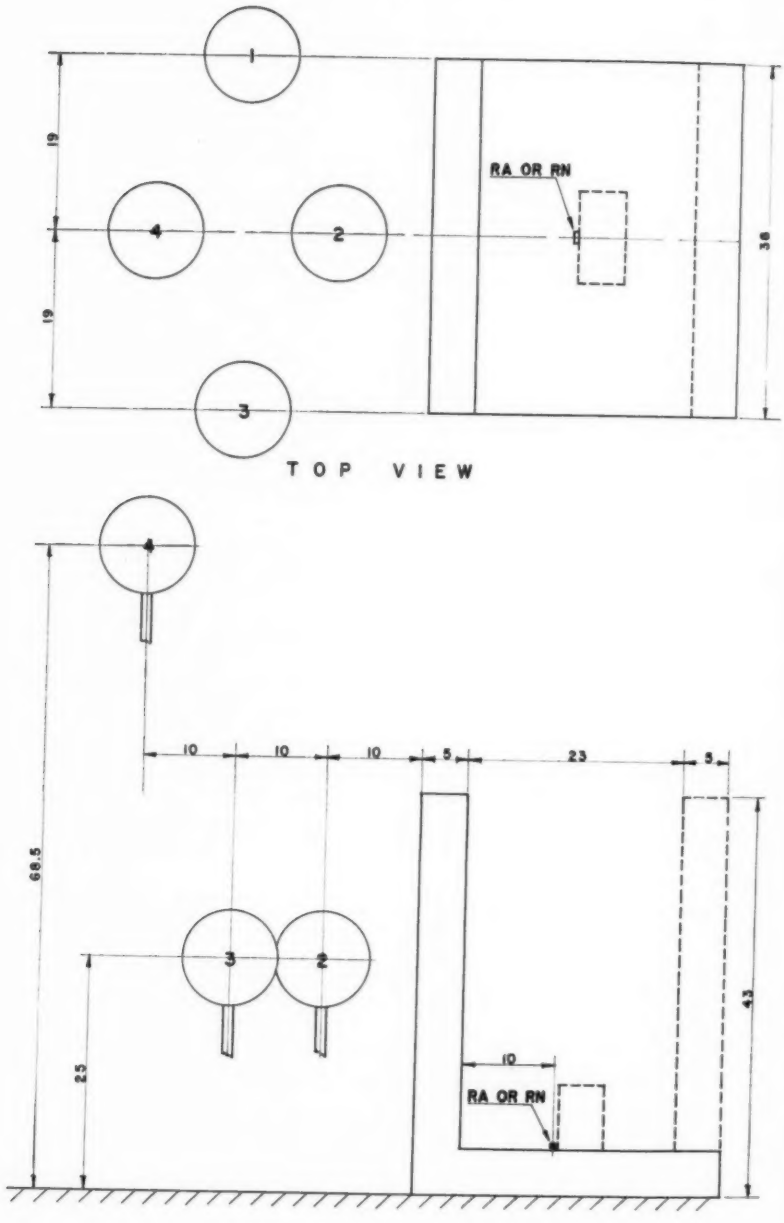

Fig. 4. Experimental set-up used for protection measurements of L- and U-shaped lead shields.

may be explained by the scattered radiation reaching the ionization chamber from the lead containers used with the non-collimated beam. It is, therefore, important to select the absorption curve which is obtained with an experimental arrangement which simulates closely conditions met in practice. The set-up used for B was

arranged with that in mind, and the results, therefore, are applicable to most protection problems.

DISTANCE CORRECTION FOR WIDE BEAMS

Measurements were made, also, at other distances to determine how closely the dosage rate follows the inverse-square law under conditions found in practice. The results of these measurements are shown in Figure 3, where the correction factors indicate the ratio of the measured values to those calculated by applying the "inverse-square" law to the dosage rate at 100 cm. Curve A shows the results of measurements in a smaller room, 12 × 18 ft., with a ceiling height of 11 ft. The radium was located in a corner, 50 cm. from each wall, and the dosage rate was measured along a line passing through the corner and the radium. Curve B indicates the results for a large, irregular shaped room, about 23 × 27 ft., with a ceiling height of 21 ft. Here the radium was placed 50 cm. from the center of one wall and readings were made along the center line of the room. Both sets of measurements show that the correction factor increased with distance and it rose rapidly as a wall was approached. The slightly irregular values may be explained by scattering from the objects in the room. As might be expected, the correction factors were higher for the smaller room, where the ionization chamber was closer to the walls and ceiling. The experiment indicates clearly that scattered radiation may add materially to the calculated dosage rate as obtained by considering the primary radiation only. The measurements show, also, that the correction factor varies widely according to experimental conditions and it is not possible to establish standard correction curves, nor to incorporate this correction into protection charts which could be universally applicable.

LEAD PROTECTION SHIELDS

The preparation of radium or radon applicators is usually carried out behind L-shaped lead blocks, thereby reducing materially the primary radiation reaching the body of the operator. Such barriers, however, offer only very limited protection against the scattered rays from nearby walls and other objects. Various methods of reducing the scattered radiation were studied by means of the experimental arrangement shown in Figure 4. Four ionization chambers were placed at the position of the operator and measurements were made with a radon capsule resting on the lead block. The radon had an initial value of 111 mc. and was filtered with 1 mm. of platinum. The results of the measurements are shown in Table II for the four arrangements used:

TABLE II: PROTECTION MEASUREMENTS OF LEAD SHIELDS

	mr per 100 mc.-hr. at positions*			
	1	2	3	4
Experimental arrangement				
L shield against wall	15.6	31.7	15.8	5.8
L shield against wall with lead brick back of radium	13.1	30.8	13.2	2.2
L shield in middle of room	13.8	31.0	14.0	1.3
U shield against wall	15.5	29.7	15.6	3.7

* See Figure 4 for the location of positions.

(*a*) The L-shaped lead shield was placed with the back against a wall of concrete blocks.

(*b*) The arrangement was the same as (*a*), except that a 2 × 3 × 4-inch lead brick had been placed directly back of the radon applicator.

(*c*) The lead shield was placed in the middle of the room without the lead brick in place.

(*d*) The lead shield was moved back against the wall and a 2-inch (5 cm.) thick lead panel was added to the back, making the shield U-shaped.

The results show that the dose received by the operator may be cut down materially by reducing the scattered radiation. The lead brick back of the radium offers a simple and effective means of limiting the scattered radiation. In order to provide maximum protection, however, the lead brick should be close to the radium or radon and in some instances this may interfere with preparation of the applicators.

A somewhat similar improvement in protection is obtained by having the lead block located at a distance from walls and other scattering objects. This suggests placing the lead block in front of a window, where the scatter will be a minimum. The U-shaped lead block does not offer much improvement, as most of the wall is still exposed to primary radiation. Measurements were made, also, with L protection shields provided with lead glass windows, such as are used in radiologic departments. The results showed that the protection could be improved to a similar extent by the above modifications.

SUMMARY AND DISCUSSION

The results of this study show that the lead absorption coefficients obtained with narrow beams of gamma rays cannot be applied directly for determining the thickness of protective barriers. Such data should be obtained from absorption measurements made with wide beams and with an experimental set-up which represents practical conditions as closely as possible. The results of such measurements are presented in Figure 2.

In the past, scattered radiation has received too little consideration in radium-protection problems. Often a sense of security was felt if the radium was back of a lead block of sufficient thickness to reduce the primary radiation to the permissible dose, irrespective of the protection provided against scattered radiation. Much improved protection may be had if the scattered radiation is reduced by limiting the cross section of the beam or by locating the radium at a distance from scattering objects.

NOTE: The writer wishes to express his appreciation to Dr. G. Failla for his suggestions and co-operation. He also wishes to thank the Radium Chemical Co. for the loan of the radium and Gordon H. Cameron of this Laboratory for his assistance with the experimental work.

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REFERENCE

1. KAYE, G. W. C., AND BINKS, W.: Emission and Transmission of X and Gamma Radiation. Brit. J. Radiol. **13:** 193–212, June 1940.

Pelvicephalometry[1]

CAPT. TOM A. KENDIG, M.C., A.U.S.

THE PURPOSE OF this paper is to present two simple tables for facilitating pelvic and fetal head mensuration. Table I is to be used in conjunction with the stereoscopic method of pelvicephalometry (1–5); Table II is to be used in conjunction with the triangulation method.

Subsequent to calculation of these tables, it was found that Hodges (9) had presented the formula used in obtaining Table I and a graph based on this formula to be used in correction of distortion in the stereoscopic method. Table II represents data identical with those obtainable from nomograms (10, 11), pelvic slide rules, and calculations from a formula or correction factor graph (9). Though neither table represents more than a presentation in tabular form of data the principles of which have been discussed by several writers, it is thought that such tabulation may prove time-saving.

STEREOSCOPIC METHOD: TABLE I

Table I is obtained from the formula $X = F\left(\frac{T}{S+T}\right)$, where X is the true length of any diameter parallel to the film, F the image length of the diameter as measured on the film, T the total tube shift, and S the image shift on the superimposed stereoroentgenograms. By using a 3-inch tube shift, substituting various values of image shift and film image measurement in the formula, and correcting for image shift of the lead markers used in the method, the data for Table I were obtained.

Table I, then, is a correction table for diameters of the pelvis or fetal head which are parallel to the film. In the anteroposterior film, all transverse diameters of the pelvis will be in a plane parallel to the film. With the fetal head in an approximately transverse position with reference to the maternal pelvis, the occipito-frontal and suboccipito-bregmatic diameters will be parallel to the film; with the head in a sagittal position with reference to the pelvis, the biparietal diameter will be parallel to the film.

General Roentgen Technic

1. Anteroposterior stereoroentgenograms are obtained with the patient in the supine or erect (10) position, with an exact 3-inch tube shift, 36-inch target-film distance, and Potter-Bucky diaphragm.

2. Two lead markers are placed on top of the table beneath the patient's buttocks, one on either side, in such a manner that the image of both markers will appear on both films.

Measuring Image Shift and Film Diameters

1. On one of the films draw the transverse diameters of the pelvis which it is desired to measure (the maximum transverse diameters of the pelvic inlet and outlet, intraspinous diameter, and any other arbitrary diameters sufficiently well visualized), extending these lines well past the ends of the diameters. Indistinct landmarks such as the mesial edges of the ischial spines should be marked on both films by perforating the films with a pointed instrument so that they may be seen when the films are superimposed.

2. Place the films together with the marked film on top, accurately superimposing the images of the lead markers.

3. With a pointed instrument, perforate both films at the points where the lateral edge of the pelvic inlet on both films crosses the line representing the maximum transverse diameter of the inlet. Similarly, perforate both films at the points where the most mesial edge of the ischial spines on both films crosses the line representing the intraspinous diameter. The same is done with any other transverse diameter marked

[1] From the Radiological Branch, Letterman General Hospital, San Francisco, Calif. Accepted for publication in March 1945.

Film Measurement (millimeters)	Image Shift (millimeters)													
	5	7	9	11	13	15	17	19	21	23	25	27	29	31
80	72	70	68	67	65	64	63	61	60	59	58	57	56	55
82	73	72	70	69	67	66	64	63	62	60	59	58	57	56
84	75	73	72	70	69	67	66	64	63	62	61	60	59	58
86	77	75	73	72	70	69	67	66	65	63	62	61	60	59
88	79	77	75	74	72	70	69	68	66	65	64	63	61	60
90	80	79	77	75	74	72	70	69	68	66	65	64	63	62
92	82	80	78	77	75	74	72	71	69	68	67	65	64	63
94	84	82	80	79	77	75	74	72	71	69	68	67	66	65
96	86	84	82	80	79	77	75	74	72	71	70	68	67	66
98	88	86	84	82	80	78	77	75	73	72	71	70	68	67
100	89	87	85	83	82	80	78	77	75	74	72	71	70	69
102	91	89	87	85	83	82	80	78	77	75	74	72	71	70
104	93	91	89	87	85	83	82	80	78	77	75	74	72	71
106	95	93	90	89	87	85	83	82	80	78	77	75	74	73
108	97	94	92	90	88	86	85	83	81	80	78	77	75	74
110	98	96	94	92	90	88	86	85	83	81	80	78	77	76
112	100	98	96	94	92	90	88	86	85	83	81	80	78	77
114	102	100	97	95	93	91	89	88	86	84	83	81	79	78
116	104	101	99	97	95	93	91	89	88	86	84	82	81	80
118	106	103	101	99	97	94	93	91	89	87	85	84	82	81
120	107	105	102	100	98	96	94	92	91	89	87	85	84	82
122	109	107	104	102	100	98	96	94	92	90	88	87	85	84
124	111	108	106	104	102	99	97	95	94	92	90	88	86	85
126	113	110	108	105	103	101	99	97	95	93	91	90	88	87
128	115	112	109	107	105	103	100	98	97	94	93	91	89	88
130	116	114	111	109	106	104	102	100	98	96	94	92	91	89
132	118	115	113	110	108	106	103	101	100	97	96	94	92	91
134	120	117	114	112	110	107	105	103	101	99	97	95	93	92
136	122	119	116	114	111	109	107	104	102	100	98	97	95	93
138	124	121	118	115	113	110	108	106	104	102	100	98	96	95
140	125	122	119	117	115	112	110	107	105	103	101	100	98	96
142	127	124	121	119	116	114	111	109	107	105	103	101	99	98
144	129	126	123	120	118	115	113	111	108	106	104	103	100	99
146	131	128	125	122	120	117	114	112	110	108	106	104	102	100
148	132	129	126	124	121	118	116	114	111	109	107	105	103	102
150	134	131	128	125	123	120	118	115	113	111	109	107	105	103
152	136	133	130	127	124	122	119	117	114	112	110	108	106	105
154	138	135	131	129	126	123	121	118	116	114	112	110	107	106
156	140	136	133	130	128	125	122	120	117	115	113	111	109	107
158	141	138	135	132	129	126	124	121	119	117	115	112	110	109
160	143	140	137	134	131	128	125	123	121	118	116	114	112	110

TABLE I: DISTORTION CORRECTION TABLE FOR THREE-INCH TUBE SHIFT

The value in millimeters of the image shift of the desired transverse diameter as determined from the stereoroentgenograms is found in the horizontal column at the top of the table. The value in millimeters of the film measurement of the desired transverse diameter is found in the vertical column at the left of the table. Where these two meet, read the corrected value of the desired diameter.

on the top film. Likewise, perforate both films at the most lateral point on both images of the fetal skull. In all of these it is necessary to make the perforations at one end of the diameter only, as the image shift is equal at both ends.

4. Separating the films and inspecting the one having the marked diameters, it will be seen that the distance between the perforations at one end of a diameter represents the image shift for that diameter. The length of each diameter and the image shift for that diameter are measured in millimeters and recorded on the film along the line representing that particular diameter. The image shift for the fetal skull is measured and recorded on the film as are the occipito-frontal and suboccipito-bregmatic diameters (or, if the skull be in a sagittal position with reference to the pelvis, the biparietal diameter is recorded instead).

5. Having recorded the length of each diameter and the image shift for each, merely find these in Table I and read the corrected value in millimeters.

6. In the event that the measured diameter is larger than those included in the table, find the corrected value for one-half the measured diameter and multiply this figure by two to obtain the true value of the diameter.

"BT" and "OT" (centimeters)

Film Measurement (millimeters)	BT 26 / OT 13	28 / 14	30 / 15	32 / 16	34 / 17	36 / 18	38 / 19	40 / 20	42 / 21	44 / 22	46 / 23
80	64	63	63	62	61	60	59	58	57	56	55
82	66	65	64	63	62	61	61	60	59	58	57
84	68	67	66	65	64	63	62	61	60	59	58
86	69	68	67	66	65	64	63	63	62	61	60
88	71	70	69	68	67	66	65	64	63	62	61
90	72	71	70	69	68	67	66	65	64	63	62
92	74	73	72	71	70	69	68	67	66	65	64
94	76	75	74	73	71	70	69	68	67	66	65
96	77	76	75	74	73	72	71	70	69	68	67
98	79	78	77	76	74	73	72	71	70	69	68
100	80	79	78	77	76	75	74	73	72	71	69
102	82	81	80	79	78	76	75	74	73	72	71
104	84	82	81	80	79	78	77	76	74	73	72
106	85	84	83	82	81	79	78	77	76	75	74
108	87	86	85	83	82	81	80	79	77	76	75
110	88	87	86	85	84	82	81	80	79	78	76
112	90	89	88	86	85	84	83	81	80	79	78
114	92	90	89	88	87	85	84	83	82	81	79
116	93	92	91	90	88	87	86	84	83	82	81
118	95	94	92	91	90	88	87	86	85	84	82
120	96	95	94	93	91	90	88	87	86	85	83
122	98	97	95	94	93	91	90	89	87	86	85
124	100	98	97	96	94	93	91	90	89	88	86
126	101	100	99	97	96	94	93	92	90	89	88
128	103	101	100	99	97	96	95	93	92	90	89
130	105	103	102	100	99	97	96	95	93	92	90
132	106	105	103	102	100	99	98	96	94	93	92
134	108	106	105	104	102	100	99	97	96	95	93
136	109	108	106	105	103	102	101	99	97	96	94
138	111	110	108	107	105	103	102	100	99	97	96
140	113	111	110	108	106	105	103	102	100	99	97
142	114	113	111	110	108	106	105	104	102	100	99
144	116	114	113	111	110	108	106	105	103	102	100
146	117	116	114	113	111	109	108	106	105	103	101
148	119	118	116	114	113	111	109	108	106	105	103
150	121	119	118	116	114	112	111	109	107	106	104
152	122	121	119	117	116	114	112	111	109	107	106
154	124	122	120	119	117	115	114	112	110	109	107
156	125	124	122	121	119	117	115	113	112	110	108
158	127	125	124	122	120	118	117	115	113	112	110
160	129	127	125	124	122	120	118	116	114	113	111

TABLE II: DISTORTION CORRECTION TABLE FOR SAGITTAL PLANE OF PELVIS, TUBE-FILM DISTANCE 36 INCHES
The external bitrochanteric diameter, "BT," or the midsacral-table top measurement, "OT," in centimeters is found in the horizontal columns at the top of the table. The desired sagittal plane diameter in millimeters is found in the vertical column at the left of the table. Where these meet, read the corrected value in millimeters.

TRIANGULATION METHOD: TABLE II

Table II is used to correct diameters in the sagittal plane of the pelvis as measured on the lateral film. These corrected diameters with the transverse diameters obtained as described above give all the necessary true pelvic measurements. If the fetal head is lying in the pelvic inlet, an additional measurement may be obtained to supplement those obtained from the anteroposterior film.

Table II is obtained from the formula $X = F\left(\frac{H - O}{H}\right)$, where X is the true measurement of any diameter in the sagittal plane of the pelvis, F the length of this diameter as measured on the film, H the target-film distance, and O the distance of the sagittal plane from the film. By using a target-film distance of 36 inches, substituting various values of film measurements and sagittal plane-film distances, and correcting for a tabletop-film distance of 5 cm., the data for Table II were obtained.

General Roentgen Technic

A single lateral film of the pelvis is made at a 36-inch target-film distance. If the film is made in the erect position, the ex-

ternal bitrochanteric diameter ("BT" in Table II) is measured and recorded by the technician. If the film is made with the patient in the horizontal position, the distance from the center of the sacrum to the top of the table ("OT" in Table II) may be measured instead of the external bitrochanteric diameter, as an appreciable error may otherwise be introduced due to compression of the underlying soft tissue.

Correction of Film Measurements

To correct any diameter in the sagittal plane of the pelvis (anteroposterior diameter of the inlet, subpubic tip of sacrum measurement, etc.), it is necessary only to measure the diameter in millimeters on the film and, using either the value of the external bitrochanteric diameter ("BT") or the midsacral-tabletop measurement ("OT") in Table II, read the corrected value from the table.

SUMMARY AND CONCLUSIONS

1. Two simple tables to be used in pelvicephalometry have been presented. Table I is to be used in correction of transverse pelvic diameters and fetal head diameters as seen on anteroposterior stereoroentgenograms. Table II is to be used in correction of sagittal plane diameters as seen on the lateral film.

2. The method is simple, requires no special apparatus either for making the films or in correction of distortion and also permits stereoscopic viewing of the birth canal.

NOTE: The author wishes to express his appreciation to Major A. E. Imler, M.C., Radiological Branch, Letterman General Hospital, for his valuable suggestions and for editing the manuscript.

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BIBLIOGRAPHY

1. CHAMBERLAIN, W. E., AND NEWELL, R. R.: Pelvimetry by Means of the Roentgen Ray. Am. J. Roentgenol. **8:** 272, 1921.

2. JOHNSON, C. R.: The "Radiogrameter." A Scale for Mensuration by Means of the Roentgen Ray. Radiology **6:** 131–137, 1926.

3. JOHNSON, C. R.: Mensuration and Localization by Means of the Roentgen Ray. Radiology **8:** 518–521, 1927.

4. JOHNSON, C. R.: Stereoroentgenometry, Method for Mensuration by Means of the Roentgen Ray. Am. J. Surg. **8:** 151–163, 1930.

5. HODGES, P. C.: Roentgen Pelvimetry and Fetometry. Am. J. Roentgenol. **37:** 644–662, 1937.

6. JOHNSON, C. R.: Pelvimetry by Stereoroentgenometry. Am. J. Roentgenol. **38:** 607–619, 1937.

7. BALL, R. P.: Roentgen Pelvimetry and Fetal Cephalometry. Surg., Gynec. & Obst. **62:** 798–810, 1936.

8. BALL, R. P.: Pelvicephalometry. Radiology **31:** 188–197, 1938.

9. HODGES, P. C., AND HAMILTON, J. E.: Pelvic Roentgenography in Pregnancy: Further Experiments with 90 Degree Triangulation Methods. Radiology **30:** 157–166, 1938.

10. BALL, R. P., AND GOLDEN, R.: Roentgenographic Obstetrical Pelvicephalometry in the Erect Posture. Am. J. Roentgenol. **49:** 731–741, 1943.

11. HOLMQUEST, H. J.: Nomogram for Roentgenographic Mensuration. Radiology **31:** 198–205, 1938.

Studies in Vitro on Cellular Physiology

The Effect of X-Rays on the Survival of Cells[1]

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THE IMPORTANCE of x-rays in the therapy of cancer and other diseases has stimulated a considerable number of investigations on the effect of this agent on cells *in vitro*, in order to obtain a biologic test of dosage and to determine the mechanism of the action of the rays. Much of this work has been done with cells from plants and invertebrate animals, such as yeast and eggs of *Drosophila*. Most investigators realized, however, that it would be desirable to use cells from mammalian sources and preferably from man. Accordingly, every new *in vitro* method for the study of living cells was soon utilized to determine the effect of x-rays.

The development of methods for transplantation of tumors in animals led to the investigations by Contamin in 1909 (1), Wedd and Russ in 1912 (2), Wood and Prime in 1915 (3), and more recently by Crabtree and Cramer in 1934 (4). These men subjected pieces of a transplantable tumor to x-rays or radium and tested the effectiveness of the radiation by inoculation of the irradiated tissue into animals. An analogous method was used by Rahm and Koose (5), who grafted irradiated and nonirradiated pieces of skin.

The technic of tissue culture has been repeatedly used to study the effect of x-rays. The early workers in this field were Wood and Prime in 1914 (6), and Kimura in 1919 (7). A review of the literature was published by Spear in 1935 (8). More recently Stenstrom, King, and Henschel (9) studied the effect of x-rays on cultures of lymph nodes, and Osgood (10) on cultures of human bone marrow.

Warburg's manometric method for studying respiration and metabolism of cells was utilized to determine the effect of x-rays by Frik and Posener in 1926 (11), Holmes (12), Crabtree (13), and Goldfeder and Fershing (14).

A technic which may be called a deferred histologic method was used by Warren and Whipple (15) and by Colwell (16) to study the effect of radiation on autolysis of tissues.

In this laboratory, the method of unstained cell counts has been found useful in studying the reactions of cells to physical and chemical reagents, such as heat (17), oxygen (18), glucose (18), antiseptics (19), and anisotonic solutions (20). The method was used in this study to determine whether irradiation with x-rays affects the survival of cells in suspensions derived from the thymus, spleen, bone marrow, and testis of rabbits and from normal and leukemic blood of man.

THYMUS

Under aseptic conditions, the thymus of a rabbit was removed and chopped up with scissors after the addition of a small amount of phosphate-Ringer solution (5 per cent of a fifteenth-molar phosphate buffer *p*H 7.6 in Ringer's solution). The suspension was filtered through an 80-mesh Monel metal wire screen in a Seitz filter and then centrifuged for five minutes at approximately 1,200 revolutions per minute. The precipitated cells were resuspended in phosphate-Ringer solution to make a concentration of approximately 200 viable cells per millimicroliter. Bacteriologic cultures in broth were made to check the sterility. The suspension was distributed in 0.2 c.c. amounts in small pyrex test tubes (100 × 13 millimeters).

[1] From the Tumor Research Unit, Veterans Administration, Hines, Ill. Published with the permission of the Medical Director of the Veterans Administration, who assumes no responsibility for the opinions expressed or the conclusions drawn by the author. Accepted for publication in April 1945.

The suspensions in the test tubes were irradiated at room temperature (78° F.) with the following factors: 250 kv., 10 ma., 50 cm. distance, 1 mm. aluminum filter, approximately 120 r per minute, half-layer value 0.7 mm. copper. The dosage from 20 to 5,000 r was measured by an integron which was adjacent to the test tubes during irradiation. The pyrex glass of the tubes absorbed 5 to 10 per cent of the radiation so that the suspension received only 90 to 95 per cent of the stated dosage. The irradiation was performed under the supervision of Major Harry Slobodin, M.C.

The microscopic objective was a 4-mm. lens, n.a. 0.85, and the eyepieces were wide field with a magnification of 15 times. The counts were expressed as the number of cells per millimicroliter in the incubated suspension. Previous work has shown that the unstained cells may be assumed to be viable and the stained cells dead.

Smears were made of the mixture of suspension and eosin and were stained by Gram's method to rule out the presence of bacteria. The mixture was also centrifuged, and smears on cover slips were made of the precipitated cells. The preparations

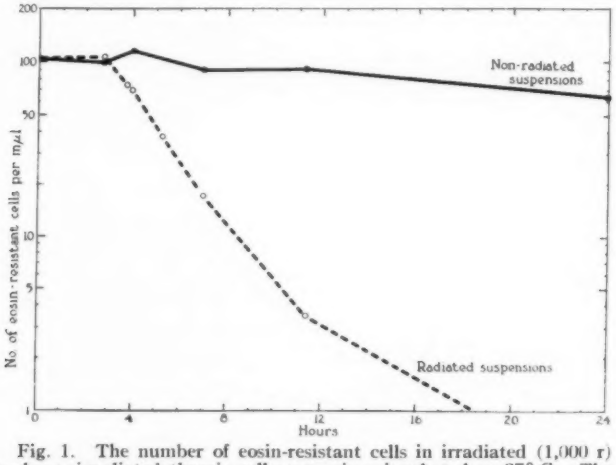


Fig. 1. The number of eosin-resistant cells in irradiated (1,000 r) and non-irradiated thymic cell suspensions incubated at 37° C. The abscissa represents the time of incubation in hours; the ordinate, the logarithm of the number of eosin-resistant cells per millimicroliter. Irradiation caused a rapid decrease in the number of unstained cells after a latent period of three hours.

After irradiation, the tubes were stoppered and incubated in a water bath at 37° C. During incubation, they were shaken horizontally at a rate of 140 times per minute. At varying intervals, counts were made of the suspensions. Eosin 1:1,000 in Tyrode's solution at *p*H 7.4 was added to the suspensions in the test tubes to make a final volume of 4.0 c.c. The mixture was shaken for two minutes, a drop was placed in a hemacytometer, and a count was made of the number of stained, unstained, and red blood cells. The hemacytometer was equipped with the thin polished cover slip of the Petroff-Hausser counting chamber.

were stained with hematoxylin and eosin and by Wright's or Giemsa stain for cytologic study.

A suspension derived from the thymus of a rabbit was irradiated with 1,000 r, was incubated at 37° C., and was examined every few hours. The number of unstained cell counts in an irradiated and in a non-irradiated control suspension is shown in Figure 1. The graph shows that irradiation of the suspension did not appreciably affect its viable cell count during the first three hours of incubation (count changed from 103 to 109 cells). After the third hour, the count of viable cells decreased

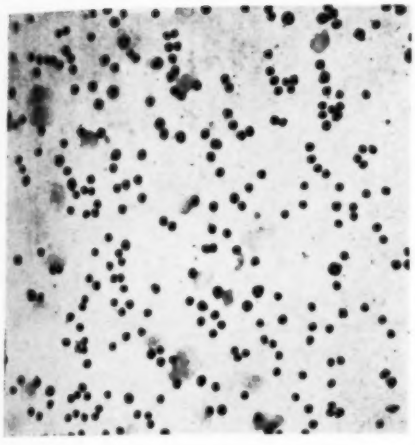
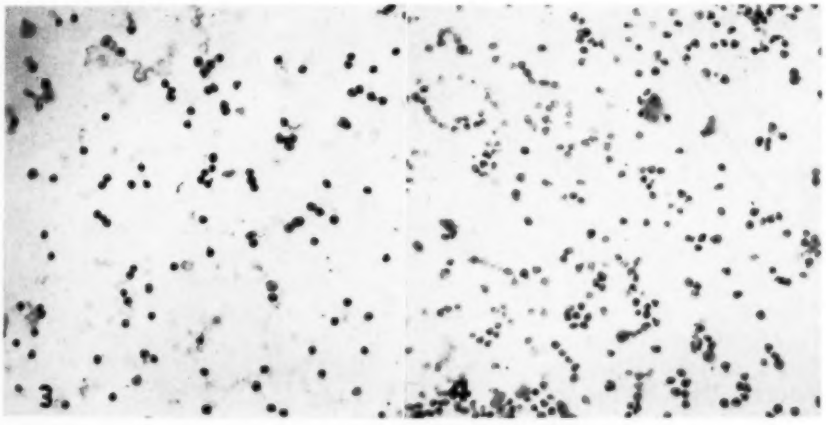


Fig. 2. Smear of thymic cell suspension before irradiation and incubation; stained with hematoxylin and eosin; ×250. Nearly all of the cells are lymphocytes which are well stained and are morphologically normal. A small number of cells are enlarged or ruptured and stain poorly.

hours of incubation (from 103 to 62.7 cells).

Smears of the suspension before irradiation and incubation showed on microscopic examination (Fig. 2) numerous small, and a few large, well preserved and well stained lymphocytes which were apparently normal in morphologic appearance. A few cells in the smear were larger than normal, irregular in outline, with large nuclei which stained light purplish in color and had no definite structure. These cells were obviously in various stages of degeneration.

In smears of non-irradiated suspensions incubated for forty-eight hours, approximately half of the lymphocytes were well preserved and normal in appearance (Fig. 3). In contrast, smears of the irradiated suspension incubated for twenty-four hours consisted almost exclusively of slightly enlarged cells (Fig. 4) with poorly stained nuclei. The cells were evidently in an



Figs. 3 and 4. Smears of non-irradiated and irradiated thymic cell suspensions. Fig. 3 shows the non-irradiated suspension, incubated for 48 hours at 37° C.; stained with hematoxylin and eosin; ×250. Approximately one-half of the cells are well stained lymphocytes; the rest are enlarged, poorly stained, and evidently undergoing degeneration. The smear indicates that many thymic cells remained morphologically normal after 48 hours of incubation at 37° C.

Fig. 4 is a smear of thymic cell suspension which was exposed to 1,000 r and was incubated for 24 hours at 37° C.; stained with hematoxylin and eosin; ×250. Nearly all of the cells are slightly enlarged and stained faintly or irregularly with hematoxylin. The smear shows that irradiated thymic cells underwent morphologic degenerative changes after incubation at 37° C.

rapidly and in twenty-four hours only 0.4 viable cells per millimicroliter were found. In contrast, the non-irradiated suspension showed only a moderate decrease in the unstained cell count after twenty-four

early stage of degeneration. Normal lymphocytes were infrequent. In other experiments, suspensions that were irradiated and incubated for twenty-four and forty-eight hours gave smears consisting of

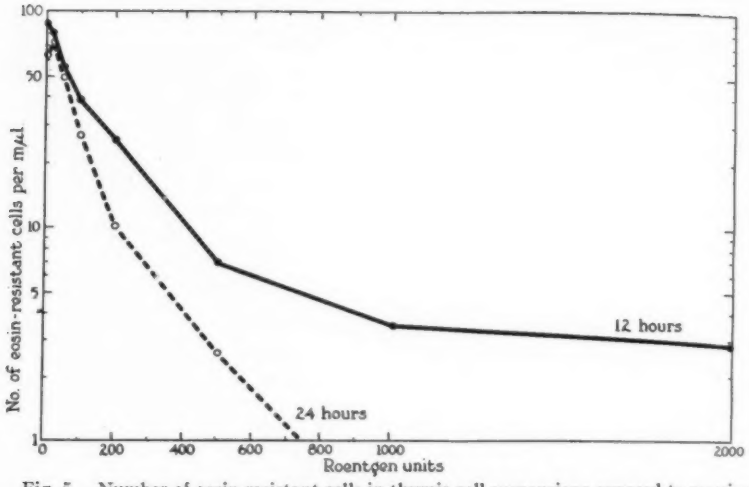


Fig. 5. Number of eosin-resistant cells in thymic cell suspensions exposed to varying dosages of radiation and incubated for 12 and 24 hours at 37° C. Irradiation with 50 r and incubation caused a slight but appreciable decrease in the number of eosin-resistant cells.

large ruptured cells and debris which took a light basophilic stain. Evidently the dead cells in the suspensions were fragile and were readily traumatized in preparing the smear. It may be concluded from the histologic observations that lymphocytes in thymic suspensions underwent degenerative changes following irradiation with 1,000 r and incubation for twenty-four hours.

The findings obtained by the method of unstained cell counts and by smears were in agreement. It seemed that irradiation with 1,000 r killed lymphocytes after a short latent period. The cytocidal action was evidenced by the capacity of the irradiated and incubated lymphocytes to stain with eosin in suspension and by the degenerative morphologic cellular changes observed in smears.

To determine the effect of dosage, a suspension derived from the rabbit thymus was subjected to 20 to 2,000 r of radiation and was examined after twelve and twenty-four hours of incubation. The unstained cell counts are shown in Figure 5. It is seen from the graph that, between 50 and 1,000 r, the greater the dosage of radiation, the greater was the decrease in the number of viable cells. Increasing the amount of radiation above 1,000 r failed to increase appreciably the radiation effect. Below 50 r, no definite effect on the viability of thymic cells was discernible.

SPLEEN

Suspensions derived from the spleen of the rabbit were prepared in the same manner as those from the thymus. In the original suspension, the differentiation of unstained, stained, and red blood cells in the hemacytometer was relatively easy, as the red cell could be recognized by its sharp outline, its yellowish color, its spherical shape, and the absence of any internal structure. In contrast, the unstained cell had a softer outline, a slightly bluish color, and a somewhat flattened, finely granular surface. In incubated suspensions, differentiation between the unstained cell and the enlarged distorted erythrocyte could be done with facility and confidence only by an individual with experience in counting cells.

A suspension derived from rabbit spleen was subjected to 1,000 r of radiation and was examined at irregular intervals. The unstained cell counts on the irradiated and on a control, non-irradiated suspension are shown in Figure 6. The graph shows that

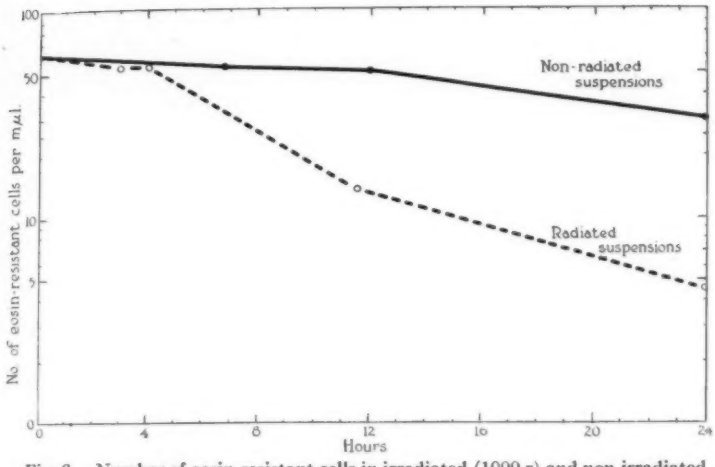


Fig. 6. Number of eosin-resistant cells in irradiated (1000 r) and non-irradiated, splenic cell suspensions incubated at 37° C. Irradiation caused a slow but definite decrease in the number of unstained cells after a latent period of four hours.

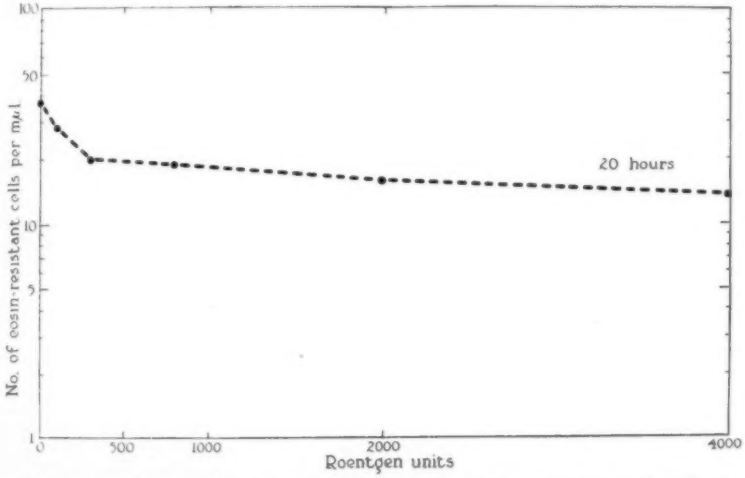


Fig. 7. Number of eosin-resistant cells in splenic cell suspensions exposed to varying dosages of radiation (100 to 4,000 r) and incubated for 20 hours at 37° C. Many cells remained eosin-resistant even after exposure to 4,000 r and incubation for 20 hours.

there was a latent period of at least four hours during which the radiation had no perceptible effect. After this latent period, the number of viable cells in the irradiated suspension decreased slowly. In the control suspension there was only a slight decline in the number of unstained cells. After twenty-four hours of incubation, 4.5 cells per millimicroliter still resisted staining in the irradiated suspension but 29 cells were resistant to eosin in the control.

A suspension derived from rabbit spleen (containing 67 viable cells per millimicroliter) was irradiated with varying dosages. Counts and smears were made after twenty hours of incubation. The effect of radiation on the unstained cell count is shown in Figure 7. The non-irradiated suspension was found to have 36.5 viable cells after twenty hours of incubation at 37° C. The suspension which was treated with 100 r had a slightly lesser number of unstainable cells, 28. Increasing the dosage up to 4,000 r decreased progressively the number

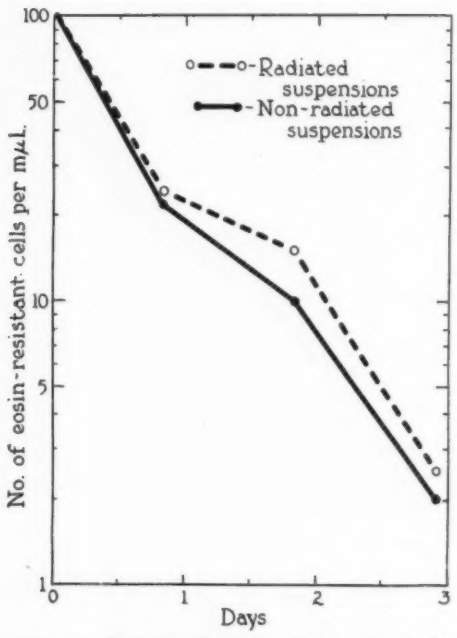


Fig. 8. Number of eosin-resistant cells in irradiated (1,000 r) and non-irradiated suspensions of bone marrow, incubated at 37° C. The radiation had no appreciable effect on the number of unstained cells in the suspension of bone marrow.

of unstained cells. It was evident that the greater the dose of radiation, the less was the number of unstained cells in the suspension.

There was one important difference in the effect of x-rays on suspensions derived from the spleen and the thymus. It was seen in Figure 1 that irradiation of the thymic suspension with 1,000 r caused an almost complete disappearance of the unstained cells in twenty-four hours (the count decreased from 103 to 0.4). In contrast, treatment of the splenic suspension with 4,000 r caused only a moderate decrease in the viable cells in twenty hours (from 67 to 13.5 cells). What is the cause of the difference? In counting the number of unstained cells in the splenic suspension irradiated with 4,000 r and incubated for twenty hours, it was observed that the unstained cells were large (12–15 micra in diameter), with many conspicuous, refractive granules. The persisting cells were evidently not lymphocytes. It appeared that radiation had killed the lymphocytes but not the cells with granules.

To study in detail the radiosensitivity of various types of cells, smears were made of the suspensions. The stained smears of the original splenic suspension had numerous small and large, well stained lymphocytes and a few polymorphonuclear leukocytes. Most of the cells in suspensions incubated for twenty-four hours were, on the smears, in various stages of degeneration. The persisting well stained cells were moderate in number, and most of them were small lymphocytes. After irradiation and incubation, nearly all the cells in the smears were degenerated. The few well preserved cells were found to be neutrophilic and eosinophilic polymorphonuclear leukocytes. These observations indicated that irradiation and incubation caused degenerative changes in the lymphocytes but not in the granulocytes.

BONE MARROW

Bone marrow was obtained aseptically from the femurs of rabbits. The tissue was chopped up slightly with scissors and, by means of a piston, was pushed through an 80-gauge Monel metal wire screen in the barrel of a syringe. The suspension was then washed once with phosphate-Ringer solution and counts were made in the usual way. Counting of the cells in the hemacytometer was somewhat difficult, due to the necessity of differentiating between the unstained cells on the one hand and the hemoglobin-containing erythrocytes and normoblasts on the other.

A suspension of bone marrow was subjected to 1,000 r and was incubated in a water bath at 37° C. Counts and smears were made daily. The numbers of unstained cells in irradiated and non-irradiated suspensions are shown in Figure 8. It can be seen that the viable cells in the irradiated suspension decreased at approximately the same rate as those in the non-irradiated control. In other words, radiation had no apparent effect on the cells of the bone marrow according to the method of unstained cell counts.

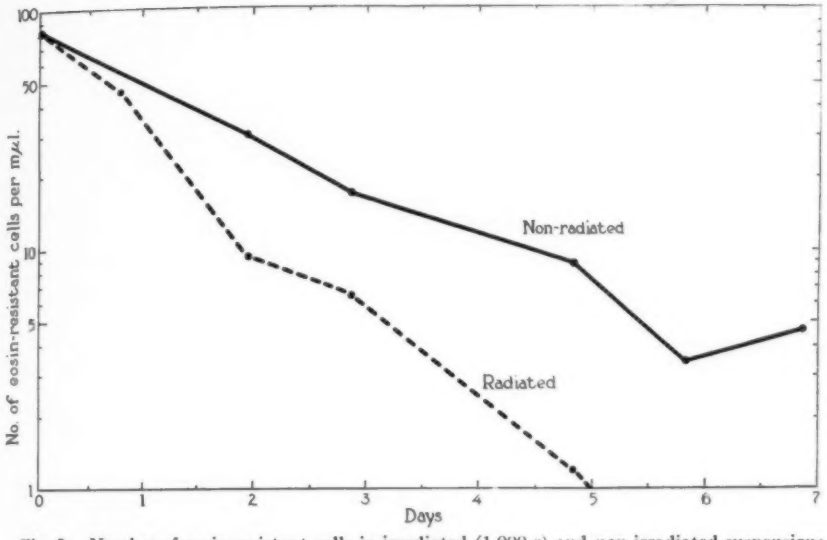


Fig. 9. Number of eosin-resistant cells in irradiated (1,000 r) and non-irradiated suspensions of normal human blood cells, incubated at 37° C. The irradiation caused a definite decrease in the number of unstained cells. In the non-irradiated suspension, many cells remained eosin-resistant even after seven days of incubation at 37° C.

Cytologic smears of the suspension of bone marrow were studied. No definite differences in the types of cells or in their morphologic appearance were observed in smears of the irradiated and control suspensions.

TESTIS

Suspensions prepared from the testes of immature or partly mature rabbits were irradiated and incubated as described previously. The results obtained by the method of unstained cell counts are shown in Table I. It is seen that the testicular suspension irradiated with 1,000 r had approximately the same unstained cell counts as the non-irradiated. The testicular cells in suspension were evidently resistant to the radiation.

Smears of the original testicular suspension had moderate sized and large cells with large nuclei and a considerable amount of cytoplasm. Only a small percentage of cells were in mitotic division. A few mature sperms were observed in the smears. After incubation for twenty-four hours, a moderate number of cells showed early and late signs of degeneration. The well preserved cells were similar in appearance to those seen in the suspension before incubation, but a few cells were very large and had 2 to 5 moderate-sized nuclei. No differences were observed in the smears obtained from irradiated and non-irradiated suspensions.

TABLE I: EFFECT OF X-RAYS AND INCUBATION AT 37° C. ON SUSPENSIONS DERIVED FROM THE RABBIT TESTICLE

Hours of Incubation at 37° C.	No. of Eosin-Resistant Cells per Millimicroliter	
	Suspension Irradiated with 1,000 r	Suspension Not Irradiated
0	...	135
21.5	102	85
28.5	64	76
45.7	30	34

NORMAL HUMAN BLOOD

Blood (40 c.c.) from normal adult men was obtained and mixed with sodium citrate. After centrifugation of the blood, the buffy coat was transferred to hematocrit tubes and was again centrifuged at 4,000 revolutions per minute for thirty minutes. The white cells were then removed, washed once with isotonic saline

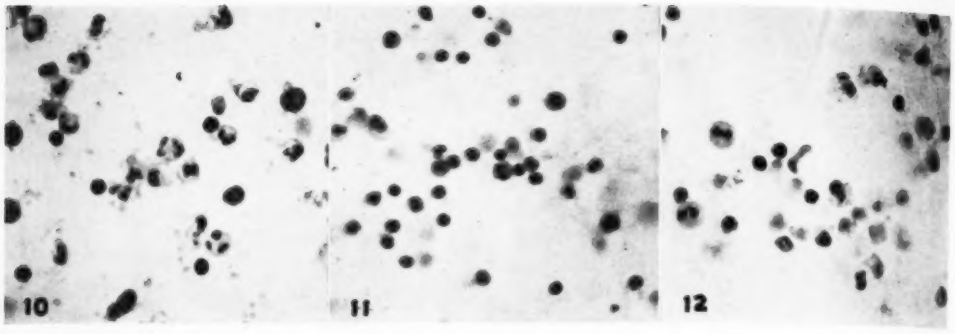


Fig. 10. Smear of suspension of normal human blood cells before irradiation and incubation; stained with hematoxylin and eosin; ×375. The cells are neutrophilic and eosinophilic polymorphonuclear leukocytes and lymphocytes. An occasional cell is poorly stained.

Fig. 11. Smear of non-irradiated suspension of normal human blood cells incubated for three days at 37° C.; stained with hematoxylin and eosin; ×375. More than half of the cells are well stained and are seen to be lymphocytes and eosinophils. The rest of the cells are enlarged and poorly stained. The neutrophilic polymorphonuclear leukocytes did not survive satisfactorily incubation for three days at 37° C.

Fig. 12. Smear of irradiated (1,000 r) suspension of normal human blood cells incubated for three days at 37° C.; stained with hematoxylin and eosin; ×375. Most of the cells are enlarged and stain poorly. The well stained cells are lymphocytes and eosinophils. Irradiation increased the number of degenerated cells.

solution and then with phosphate-Ringer's fluid. The washed cells were resuspended in phosphate-Ringer's solution and were irradiated and incubated as in the previously described experiments. In counting the viable cells in a hemacytometer, it was observed that some cells enlarged due to flattening of the cells on the glass slide. During this process, the cells became almost transparent and the cell outlines could not be made out. Care had to be taken not to overlook these cells in the unstained cell counts.

The decrease in the number of unstained cells in the irradiated (1000 r) and in non-irradiated suspensions is shown in Figure 9. It is seen from the graph that the number of unstained cells decreased much more rapidly in the irradiated than in the non-irradiated suspensions. After four days and twenty hours of incubation, the unstained cell count was 1.2 in the irradiated, and 8.6 cells in the non-irradiated suspension. From this and other experiments, it appeared that irradiation definitely decreased the period of survival of the white blood cells from normal persons.

Further data on the survival of irradiated and non-irradiated leukocytes were obtained by examination of smears. The original non-incubated and non-irradiated suspension was found, on smear, to have many well preserved cells. Of these, 82 per cent were neutrophilic polymorphonuclear leukocytes, 11 per cent were lymphocytes and monocytes, and 7 per cent eosinophils (Fig. 10). A few cells showed degenerative changes and were not included in the differential count.

Smears of the non-irradiated suspension which had been incubated for three days were found to have (Fig. 11) many well stained, morphologically intact lymphocytes (65 per cent) and only a moderate number of neutrophils (21 per cent) and eosinophils (14 per cent). Many cells were degenerated. It appears from the smears that most of the neutrophilic leukocytes could not survive three days of incubation at 37° C., but the lymphocytes and the eosinophilic leukocytes did survive.

The suspension that was irradiated and incubated for three days was also studied by smears (Fig. 12). A high percentage of the cells in the smear were degenerated. The cells that were well preserved were predominantly lymphocytes (58 per cent), and a moderate number of eosinophils (22 per cent) and neutrophils (20 per cent). Smears of irradiated suspensions incubated for four to six days had a few lymphocytes but many intact eosinophils.

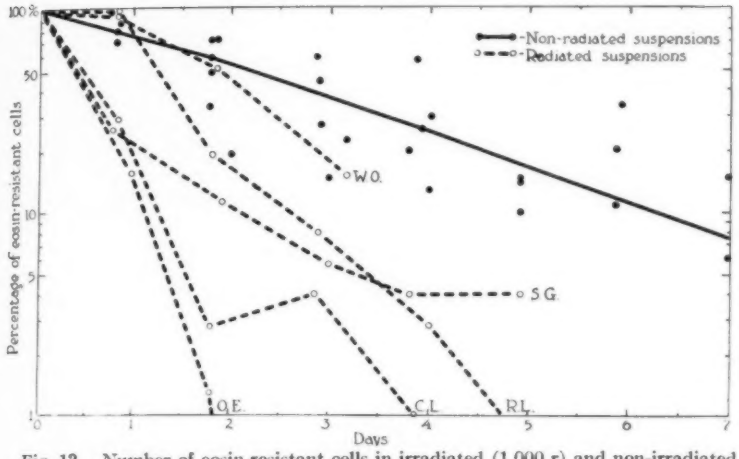


Fig. 13. Number of eosin-resistant cells in irradiated (1,000 r) and non-irradiated suspensions of the blood cells from five patients with lymphocytic leukemia; suspensions incubated at 37° C. In four of the five experiments, the irradiated suspensions had definitely fewer eosin-resistant cells than the non-irradiated suspensions.

It seemed from these studies that *in vitro* irradiation with x-rays caused the destruction of the lymphocytes of human blood after a latent period of forty-eight hours. In contrast, eosinophils seemed resistant to radiation under the same conditions. The radiosensitivity of neutrophilic polymorphonuclear leukocytes was not determined, since relatively few of these cells survived incubation for three days at 37° C.

LYMPHOCYTIC LEUKEMIC BLOOD

The white blood cells from five patients with lymphocytic leukemia were studied for radiosensitivity by the method of unstained cell counts. Four patients had been irradiated for five to eighteen days with 360 to 2,800 r prior to bleeding for these tests. Three patients had been treated for lymphatic leukemia on previous admissions, with remission of the disease.

Approximately 20 c.c. of blood were drawn and 0.8 c.c. of a 10 per cent solution of sodium citrate was added to prevent coagulation. The blood was allowed to stand for thirty to sixty minutes. During this period, the red blood cells usually settled but the white cells remained suspended in the plasma. The supernatant fluid with the leukocytes was removed and centrifuged. The precipitated cells were washed and resuspended as described for normal blood cells. The cellular suspensions were irradiated (1,000 r), an equal volume of human serum was added, and the irradiated and the control non-irradiated suspensions were incubated in the water bath. The suspension was examined daily by counts and smears. To permit representation of the five experiments on one graph, each unstained cell count was expressed as a percentage of the number of unstained cells in the original suspension. The results are shown in Figure 13.

The solid circles in the graph represent percentage of unstained cells in the non-irradiated suspension during seven days of incubation. It is seen that there was a gradual decline in the number of unstained cells. There was some variation in the results obtained with the different cellular suspensions. The variation was, however, not marked, especially when one considers that the cells were derived from five different patients and that the experimental error was fairly large.

The survival curves of the cells in the irradiated suspensions varied considerably. In one case (WO) the x-rays had no ap-

preciable effect on the survival of the cells, but in the four other cases irradiation decreased markedly the number of viable cells. The number of patients studied was too small to determine the factors responsible for the variations in the radiosensitivity of the cells.

It may be concluded from these findings that the radiation killed the cells obtained from the blood of 4 out of 5 patients with lymphatic leukemia.

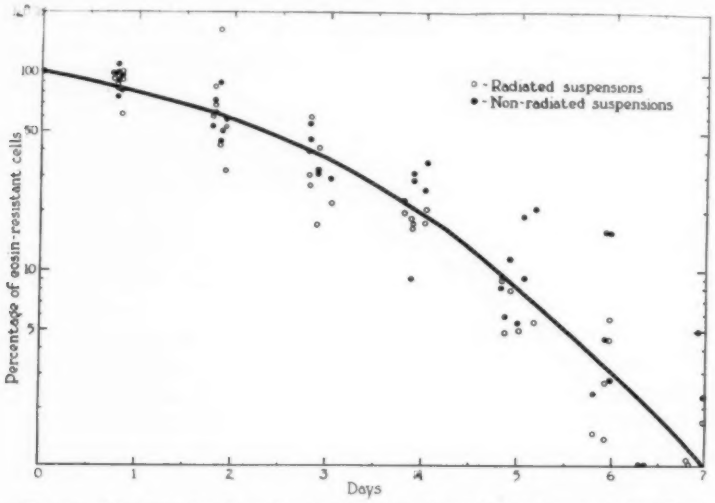


Fig. 14. Number of eosin-resistant cells in irradiated (1,000 r) and non-irradiated suspensions of the blood cells from seven patients with myelogenous leukemia; suspensions incubated at 37° C. The figure is plotted on semilogarithmic graph paper. Irradiation had little if any effect on the survival of the cells.

MYELOGENOUS LEUKEMIC BLOOD

The leukocytes of the blood from seven patients with myelogenous leukemia were prepared in suspension as described previously for cells of lymphocytic leukemia. Examination of the suspensions in a hemacytometer indicated that many of the cells had a tendency to flatten themselves against the glass and to become almost transparent. These cells were probably polymorphonuclear leukocytes.

Figure 14 shows the unstained cell counts of irradiated and non-irradiated suspensions during an incubation period of seven days. The suspensions differed in several respects, such as number of erythrocytes (158 cells per millimicroliter in the first suspension prepared and 13 cells in a later experiment), the relative number of mature and immature leukocytes, and the amount of radiation previously received by the patient. In spite of these differences and in spite of a rather large experimental error, there was fairly good consistency in the number of unstained cells in the non-irradiated suspension during seven days of incubation (Fig. 14).

A comparison of Figures 13 and 14 shows that there is a definite difference in the survival of the cells in suspensions derived from patients with the two types of leukemia, the cells of lymphocytic leukemia surviving for a longer period than the cells of myelogenous leukemia.

It is seen in Figure 14 that there was little or no difference between the percentage of unstained cells in the irradiated and the non-irradiated suspensions of myelogenous leukemic cells. In one case, the cells were exposed to 5,000 r, but even this dose of radiation had no appreciable effect. It seemed from these studies that radiation had no direct effect on the survival of myelogenous leukemic cells in suspension.

Smears of suspensions after incubation for three to six days showed that both the

irradiated and the non-irradiated suspensions had a small to moderate number of myelocytes and myeloblasts. These cells stained satisfactorily with hematoxylin and eosin or with Wright's stain, and had been presumably viable in the suspension. In comparison to the cells in the original suspension before incubation, the persisting cells were somewhat small; they had small nuclei and there was a relative increase in the ratio of cytoplasm to nucleus. These morphologic changes suggest that the immature myeloblasts and myelocytes had undergone an aging process but had failed to mature to polymorphonuclear leukocytes. A similar process was observed in suspensions of normal bone marrow of rabbits. Apparently, the suspensions lacked certain constituents which were necessary for the maturation of myelocytes and myeloblasts.

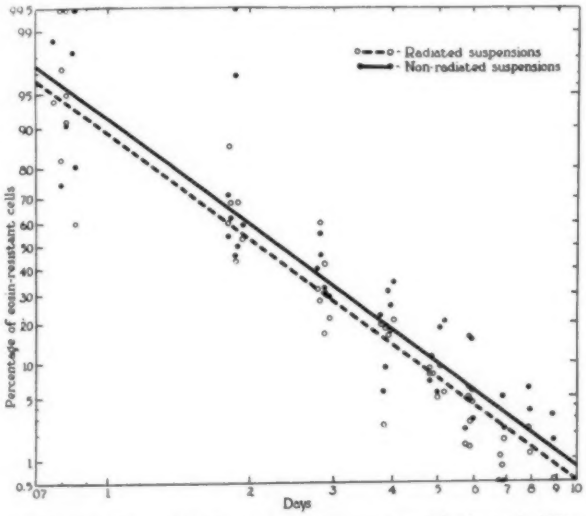


Fig. 15. Data of Figure 14 plotted on logarithmic-probability graph paper. The straight lines in the figure have been fitted by the method of least squares. The use of logarithmic-probability paper is advantageous, since the data can be represented by a straight line. The constants, the 50 and the 10 per cent survival time, can be determined from the graph.

MATHEMATICAL ANALYSIS OF THE SURVIVAL OF CELLS

A detailed mathematical analysis of the data obtained in these experiments was made (1) to check the accuracy of the previous conclusions which were obtained by inspection of graphs, (2) to derive a formula for the survival of cells, (3) to determine quantitatively the effect of radiation on cells, and (4) to measure the capacity of different types of cells to survive *in vitro*.

It was found that the data on the survival of cells in suspension could be summarized by three constants: (1) the 50 per cent and (2) the 10 per cent survival time, which represent the time when the numbers of unstained cells are reduced to 50 and 10 per cent of the original unstained cell count, and (3) the coefficient of variability, which is a measure of the variability of the survival periods of the individual cells in the suspension. Any two of these constants suffice for a complete characterization of the survival of cells and for a quantitative determination of the effect of x-rays. Although the significance of these three constants is easily understood, their mathematical derivation and calculation are involved.

The customary graphic method of repre-

senting the effect of x-rays on cells is the use of time as abscissa and percentage of surviving cells as ordinate. Another method was used in Figure 14, where the logarithm of the percentage of eosin-resistant cells was used as ordinate and time as abscissa. The former graphic method yields an S-shaped curve; the latter, a curve concave to the abscissa. Neither method is suitable for mathematical analysis. It would be preferable to use a graph which permits the representation of the survival of cells by a straight line.

In Figure 15, the data on the myelogenous leukemic cells are shown on logarithmic-probability paper (21) with the logarithm of time as abscissa and a function of the percentage of unstained cell counts as ordinate. This function has been termed normal frequency deviation by Gaddum (22), probits by Bliss (23), and probability units by Schrek (21). Inspection of the scatter diagram in Figure 15 indicates that there is a linear correlation between the logarithm of time and the probability units of the percentage. It would seem then that the logarithmic-probability paper is the best graphic method for a mathematical analysis of the survival of cells.

The representation of the survival of cells by a straight line on logarithmic-probability paper indicates that the survival periods for the individual cells can be represented by a symmetrical logarithmic frequency distribution. The geometric mean of this distribution represents the time necessary to decrease the number of unstained cells to 50 per cent of the original number. This constant may therefore be designated the 50 per cent survival period.

The geometric standard deviation of the distribution is the antilogarithm of the slope of the line on the axis of ordinates in the graph (Fig. 15). The geometric standard deviation may also be called the coefficient of variability. A relative high constant of variability probably indicates (1) a heterogeneous mixture of several types of cells in the suspension, (2) marked differences in the physiologic condition of the cells, or (3) a high experimental error.

Although the rectilinear curve in Figure 15 can be characterized completely by the 50 per cent survival time and the coefficient of variability, it is useful to use a third constant, the 10 per cent survival time. This may be defined as the time when 10 per cent of the original cells are still alive and 90 per cent of the cells have been killed by the reagent or the incubation. The 10 per cent survival time is not an independent constant but can be calculated directly from the 50 per cent survival time and the coefficient of variability.

To calculate the statistical constants, the regression equation, $y = a + bx$, was determined for the scatter diagram in Figure 15. The statistical constants could then be obtained by the formulae:

$$50\%\ survival\ time = antilog\left(-\frac{a}{b}\right)$$

$$Geometric\ standard\ deviation = antilog\left(-\frac{1}{b}\right)$$

$$10\%\ survival\ time = antilog\left(-\frac{a + 1.28155}{b}\right)$$

The graphical derivation of the statistical constants was more convenient than the calculation and was frequently sufficiently accurate. The data were plotted as in Figure 15. A straight line was drawn through the points. The intersections of the line with the 50, 34.1, and 10 per cent ordinates were noted (c, d, and e, respectively). The constants were then calculated by the formulae:

$$50\%\ survival\ time = antilog\ c$$

$$10\%\ survival\ time = antilog\ e$$

$$Geometric\ standard\ deviation = antilog(d - c)$$

In conclusion, the survival *in vitro* of irradiated and non-irradiated cells was represented graphically by a straight line on logarithmic-probability paper. The data on the survival of cells were sum-

marized by the 50 per cent survival period (or geometric mean), the 10 per cent survival period, and by the constant of variability (or geometric standard deviation). By means of these three constants, the effect of various factors on the survival of cells was measured quantitatively.

constants for the leukemic cells were calculated arithmetically and for the other cells graphically.

It is seen from the figure that the thymic and splenic cells had relatively short 50 per cent survival periods (0.90 and 0.87 days, respectively) and short 10 per cent survival

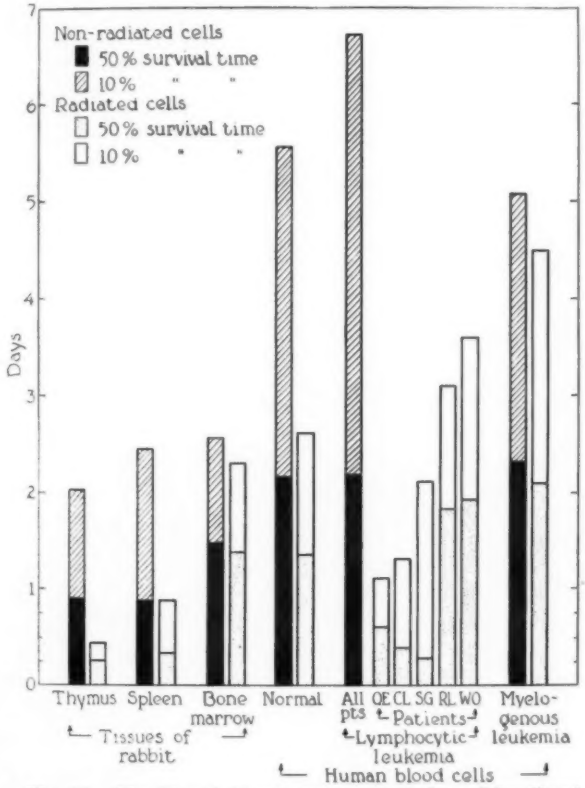


Fig. 16. The 50 and 10 per cent survival time of irradiated (1,000 r) and non-irradiated cells in suspensions derived from various organs. Irradiation decreased the survival period of cells in suspensions derived from the thymus and spleen of the rabbit and from normal and lymphocytic leukemic blood cells. Irradiation had no significant effect on cells from bone marrow and from myelogenous leukemic blood.

A COMPARISON OF THE SURVIVAL PERIODS OF DIFFERENT TYPES OF CELLS

The data on the survival of different types of suspensions were analyzed by graphic representation on logarithmic-probability paper and by calculation of the 50 and 10 per cent survival periods and the coefficient of variability. The results are summarized in Figure 16. The statistical

periods (2.02 and 2.42 days). The cells of the bone marrow had slightly longer 50 and 10 per cent survival times (1.48 and 2.55 days). The leukocytes of normal, lymphocytic, and myelogenous leukemic blood had the longest 50 per cent (2.16, 2.18, and 2.33 days, respectively) and 10 per cent survival periods (5.52, 6.67, and 5.08 days). Although the cells of lympho-

cytic leukemia had approximately the same 50 per cent survival time as those of myelogenous leukemia (2.18 and 2.33 days), the former had a considerably greater 10 per cent survival time (6.67 and 5.08 days).

In previous experiments (18) a study was made of the survival of cells in suspensions maintained at 45° C. It was found that the 10 per cent survival periods were 3.4 hours for thymic cells and 5.4 hours or more for normal and leukemic blood cells. It is seen that at both 37° and 45° C. the leukocytes of normal and leukemic blood survived a much longer period than thymic cells.

THE EFFECT OF RADIATION ON THE SURVIVAL OF CELLS

The present method of mathematical analysis permits the quantitative determination of the effect of radiation on cells. The 50 and 10 per cent survival time for the untreated thymic cells was 0.90 and 2.02 days (Fig. 16). In contrast, irradiated cells had a 50 and 10 per cent survival period of only 0.26 and 0.43 day. Similarly, the cells in suspensions from spleen and from normal and lymphocytic leukemic blood had, after irradiation, a much shorter 10 per cent survival period (0.88, 2.60, and 1.09 to 3.58 days) than the corresponding cells without radiation (2.42, 5.52, and 6.67 days). In contrast, the granulocytes from bone marrow and myelogenous leukemic blood had approximately the same 10 per cent survival periods in irradiated (2.27 and 4.50 days) and in non-irradiated suspensions (2.55 and 5.08 days).

It has been seen that the logarithmic-probability paper is useful to represent the effect of time of incubation on the percentage of unstained cell counts when the dosage of radiation is kept constant. The logarithmic-probability paper is useful also to determine the effect of varying dosage of radiation when time is kept constant. In fact, Bliss and Packard (24) used this graphic method to study the effect of radiation on the eggs of *Drosophila*.

TABLE II: EFFECT OF X-RAYS ON AEROBIC AND ANAEROBIC SUSPENSIONS OF LYMPHOCYTIC LEUKEMIC BLOOD CELLS INCUBATED AT 37° C.

	No. of Eosin-Resistant Cells per Millimicroliter	
	Suspension Irradiated with 1,000 r	Suspension Not Irradiated
Before incubation	...	158
20 hours incubation		
Anaerobic suspension	112	...
Aerobic suspension	41	106
44 hours incubation		
Anaerobic suspension	93	84
Aerobic suspension	2.4	109

In the present investigation, Figure 5 was reconstructed on logarithmic-probability paper and the dosages of radiation corresponding to 50 and 10 per cent survival were found graphically. Thymic cells incubated for twenty-four hours showed 50 and 10 per cent survival when irradiated with 100 and 310 r, respectively.

EFFECT OF ANAEROBIOSIS ON RADIOSENSITIVITY

Several factors have been studied in preliminary experiments to determine whether they have any effect on the susceptibility of lymphocytes to x-rays. The results obtained with the cells under anaerobic conditions were of particular interest.

Pieces of glass tubing (14 cm. in length and 4 mm. in external diameter) with short pieces of rubber tubing at both ends (4 cm. in length) were filled with suspensions of thymic cells of the rat and of lymphatic leukemic cells. The rubber tubing was then kinked at both ends and sealed by slipping over each end a short strip of rubber tubing (3 mm. in length). The anaerobic preparations were irradiated with 1,000 r at room temperature, were placed in a metal box in a water bath at 33° or 37° C., and were rotated at the rate of 40 revolutions per minute. The control preparations were non-irradiated anaerobic suspensions and irradiated and non-irradiated aerobic suspensions.

In a typical experiment with lymphocytic leukemic blood, the original suspension contained 158 eosin-resistant cells per millimicroliter (Table II). Under aerobic

conditions, the count decreased, after forty-four hours of incubation at 37° C., to 2.4 cells in the irradiated and to 109 in the non-irradiated suspensions. Under anaerobic conditions, the count decreased to 93 and 84 in the irradiated and non-irradiated suspensions, respectively. In this and other experiments, no appreciable differences were observed in the unstained cell counts in irradiated and non-irradiated suspensions under anaerobic conditions. It would appear that x-rays had no effect on lymphocytes under anaerobic conditions.

DISCUSSION

Following irradiation and incubation, lymphocytes obtained from the thymus, spleen, and normal and leukemic blood lost their resistance to staining with eosin in suspension and acquired degenerative morphologic changes in stained smears. The observed changes in irradiated and incubated lymphocytes indicated strongly that these cells were dead. It would seem then that x-rays had a delayed cytocidal action on lymphocytes.

Stenstrom, King, and Henschel (9) found, by means of tissue culture, that a dosage of 20 r caused a minimal decrease in the outwandering of cells from cultures of a lymph node. In the present investigation, it was observed that irradiation with as little as 50 r caused a slight but definite decrease in the unstained cell count in cellular suspensions derived from the thymus. Stenstrom's investigations by means of tissue culture and the present work by the method of unstained cell counts are in agreement that a small dose of radiation caused a physiologic change in lymphocytes.

It was observed by the method of unstained cell counts that x-rays in doses up to 5,000 r had no apparent effect on the granular leukocytes of bone marrow and on the cells of myelogenous leukemic blood. Osgood (10), on the other hand, found that irradiation of cultures of human bone marrow caused a decrease in the number of cells as compared to non-irradiated cultures. It should be noted that different methods were employed in the present and in Osgood's experiments and that the biologic phenomena studied were different. In Osgood's cultures of bone marrow, many cells were in mitotic division, and the effect of radiation was attributed to an interference or inhibition of mitosis. In the present suspensions of bone marrow, the survival of cells, and not their mitotic activity, was studied. It would seem then, from Osgood's and from the present experiments, that irradiation decreased the mitotic activity of the cells of bone marrow but did not have a direct cytocidal action on these cells.

SUMMARY AND CONCLUSIONS

Technical Methods: Cellular suspensions were prepared from the thymus, spleen, bone marrow, and testes of rabbits and from the leukocytes of normal and leukemic blood of men. The suspensions were irradiated with 20 to 5,000 r and incubated at 37° C. for one to seven days. The irradiated and control, non-irradiated suspensions were examined at periodic intervals by the method of unstained cell counts and by stained smears.

Mathematical Methods: The survivals of irradiated and of non-irradiated cells in suspension were represented graphically by a straight line on logarithmic-probability graph paper. The survival of cells was measured by two statistical constants: (1) the 50 per cent survival time and (2) either the 10 per cent survival time or the coefficient of variability. By means of these constants, it was possible to compare quantitatively the capacity of different types of cells to survive *in vitro* and to measure accurately the effect of irradiation on the survival of cells.

Findings: Exposure of thymic and splenic suspensions to 1,000 r caused no perceptible change in the number of eosin-resistant, *i.e.*, viable, cells in the first three hours of incubation but produced a relatively rapid decrease in the unstained cell counts after the short latent period. In smears of thymic suspensions subjected to

1,000 r and incubated aerobically for twenty-four hours, most of the cells were poorly stained and apparently degenerated, but many of the cells in non-irradiated suspensions stained satisfactorily. Irradiated leukocytes from normal blood and from lymphocytic leukemic blood had a shorter survival period than non-irradiated cells. Irradiation and incubation of suspensions from bone marrow, from myelogenous leukemic blood, and from the testicle had no effect on the number of eosin-resistant or viable cells when compared to non-irradiated suspensions. In contrast to the findings under aerobic conditions, radiation produced no perceptible decrease in the number of eosin-resistant lymphocytes which were irradiated and incubated in the absence of air.

Conclusions: Irradiation with x-rays had a delayed cytocidal action on lymphocytes but no appreciable action on granulocytes and testicular cells *in vitro*. The cytocidal action of radiation on lymphocytes was observed under aerobic but not under anaerobic conditions.

Veterans Administration
Hines, Ill.

REFERENCES

1. CONTAMIN, M. A.: Rayons X et souris cancéreuses. Compt. rend. Acad. d. sc. **149:** 1397–1398, 1909.

2. WEDD, B. H., AND RUSS, S.: Effect of Roentgen and Radium Radiations upon the Vitality of the Cells of Mouse Carcinoma. J. Path. & Bact. **17:** 1–11, 1912.

3. WOOD, F. C., AND PRIME, F.: Action of Radium on Transplanted Tumors of Animals. Ann. Surg. **62:** 751–765, 1915.

4. CRABTREE, H. G., AND CRAMER, W.: Action of Radium on Cancer Cells. III. Factors Determining the Susceptibility of Cancer Cells to Gamma Radiation. Eleventh Scientific Report, Imperial Cancer Research Fund, 1934, pp. 103–117.

5. RAHM, J., AND KOOSE, W.: Ein Beitrag zum Wirkungsmechanismus härter Röntgenstrahlen. Strahlentherapie **23:** 195–216, 1926.

6. WOOD, F. C., AND PRIME, F.: Action of Radium on Growing Cells. Proc. Soc. Exper. Biol. & Med. **11:** 140–142, 1914.

7. KIMURA, N.: Effects of X-Ray Irradiation on Living Carcinoma and Sarcoma Cells in Tissue Cultures in Vitro. J. Cancer Research **4:** 95–135, 1919.

8. SPEAR, F. G.: Tissue Culture. II. Its Application to Radiological Research. Brit. J. Radiol. **8:** 68–86, 280–297, 1935.

9. STENSTROM, W., KING, J. T., AND HENSCHEL, A. F.: Correlation Between Roentgen Dosage and Lymphoid Cell Migration in Tissue Cultures. Radiology **38:** 477–480, 1942.

10. OSGOOD, E. E.: Is the Action of Roentgen Rays Direct or Indirect? An Investigation of This Question by the Method of Human Marrow Culture. Am. J. Roentgenol. **48:** 214–219, 1942.

11. FRIK AND POSENER: Über den Einfluss der Röntgenstrahlen auf den Zellstoffwechsel. Fortschr. a. d. Geb. d. Röntgenstrahlen **34:** 46–48, 1926.

12. HOLMES, B. E.: Metabolism of Tissues Growing in Culture. V. Effect of Radium on the Metabolism of Cultures of Embryonic Kidney Tissue. Biochem. J. **27:** 391–396, 1933.

13. CRABTREE, H. G.: Differential Effect of Radium Radiation on the Carbohydrate Metabolism of Normal and Tumor Tissues Irradiated at Low Temperature. Biochem. J. **29:** 2334–2343, 1935.

14. GOLDFEDER, A., AND FERSHING, J. L.: Effect of Radiation on Cell Respiration. I. Respiration and Anaerobic Glycolysis of Mouse Kidney *in vitro* Following Radiation. Radiology **31:** 81–88, 1938.

15. WARREN, S. L., AND WHIPPLE, G. H.: Roentgen Ray Intoxication. III. Speed of Autolysis of Various Body Tissues After Lethal X-Ray Exposures. J. Exper. Med. **35:** 213–224, 1922.

16. COLWELL, H. A.: Method of Action of Radium and X-Rays on Living Tissues. London, Oxford University Press, 1935.

17. SCHREK, R.: Studies in Vitro on the Physiology of Normal and of Cancerous Cells. I. Effect of High Temperature and of Moccasin Venom on the Viability of Rabbit Lymphocytes and Polymorphonuclear Leukocytes as Determined by the Method of Unstained Cell Counts. Arch. Path. **35:** 857–868, 1943.

18. SCHREK, R.: Studies in Vitro on the Physiology of Normal and of Cancerous Cells. II. Survival and the Glycolysis of Cells under Aerobic and under Anaerobic Conditions. Arch. Path. **37:** 319–327, 1944.

19. SCHREK, R.: Measurement of Toxicity of Antiseptics by the Method of Unstained Cell Counts. Proc. Soc. Exper. Biol. & Med. **54:** 283–285, 1943.

20. SCHREK, R.: Studies in Vitro on Physiology of Cells: Effect of Anisotonic Solutions. Proc. Soc. Exper. Biol. & Med. **57:** 348–351, 1944.

21. SCHREK, R., AND LIPSON, H. I.: Logarithmic Frequency Distributions. A Method of Simplifying the Analysis of Asymmetrical Frequency Curves. Human Biol. **13:** 1–22, 1941.

22. GADDUM, J. H.: Reports on Biological Standards. III. Methods of Biological Assay Depending on a Quantal Response. Medical Research Council, Special Report Series No. 183, London, His Majesty's Stationery Office, 1933.

23. BLISS, C. I.: Determination of the Dosage-Mortality Curve from Small Numbers. Quart. J. Pharm. & Pharmacol. **11:** 192–216, 1938.

24. BLISS, C. I., AND PACKARD, C.: Stability of the Standard Dosage-Effect Curve for Radiation. Am. J. Roentgenol. **46:** 400–404, 1941.

EDITORIAL

Acta Radiologica

The return of *Acta Radiologica* to our book shelves is one of the welcome results of the restoration of communications with Europe. Although the journal was published regularly during the war years, retaining its vigor, refreshing originality, and scientific eminence, it was unavailable to Americans until recently. Now that the issues of the past five years have arrived, it is evident that they contain a mine of information about developments in radiology during the war period; a thorough perusal of these volumes is most rewarding.

Acta Radiologica has a notable history. It was founded in 1921 as the organ of the Scandinavian Radiological Societies, but soon came to represent Holland and Switzerland as well as Sweden, Norway, Denmark, and Finland. The editors adopted the plan which is uniform in all the Actas, that is, the publication of articles in English, French, or German, with summaries of each in all three languages. Thus it has been read with considerable facility throughout the world, and the high standard of its contents has fully justified the attention it has received. The editorship has been from the beginning in the hands of Professor Gösta Forssell, and the numerous friends of that illustrious and beloved radiologist will rejoice to learn that he is still editing the journal. The character of the latest volumes bears testimony to the fact that his high ideals and wise leadership still dominate its pages. Perhaps the best monument which this most eminent of living radiologists will leave is the journal which he did so much to found and so much to develop.

It is good to note that the excellent typography and the superb illustrations which have characterized the journal are still intact. It is easy to imagine what sacrifices must have been entailed in keeping up such a high standard both of format and of content. The editors and publishers are to be congratulated on the achievement of such a task.

The gracious custom of issuing birthday volumes, a characteristic Scandinavian tradition, is well illustrated in the issues for 1941 to 1945. Three such commemorative numbers were published during that period. The first, appearing at the end of 1941, is in honor of the fiftieth birthday of Erik Lysholm, now Chief of the Radiology Department at the Seraphimer Hospital and Associate Professor of Radiology at the Royal Caroline Institute in Stockholm. While Doctor Lysholm is best known in this country for the invention of the stationary wafer grid, he is responsible for many other technical developments and for one of the most comprehensive studies of the roentgen anatomy and pathology of the skull and its contents. The issue honoring him is replete with papers whose quality is consistent with his original and inventive mind.

The second birthday volume, which is even larger, was issued in November of 1944 in honor of the sixtieth birthday of Hugo Laurell, Professor of Radiology at the University of Uppsala. Those who have known Laurell personally will appreciate fully the esteem in which he is held by his Scandinavian colleagues. From his fertile mind has issued much of our present knowledge concerning the value of roentgen procedures in the acute abdominal conditions. He was the first to describe adequately the roentgenologic findings in

peritonitis and in certain types of intestinal obstruction. From his original work came the development of the double-contrast enema. He was one of the first to study the effects of the respiratory movements on the heart and large vessels and the changes which result from fluid in the pleural cavities and from various other abnormalities. A physiologist of distinction, Laurell has devoted much thought to the demonstration of abnormalities in the physiology of the thorax by the roentgen method. Unfortunately, because many of his original papers were published in the *Uppsala Läkareforeningen* rather than in *Acta Radiologica*, his contributions have not been as familiar to Americans as they deserved. This volume pays fitting tribute to his numerous accomplishments.

The final issue in this group of birthday volumes is dedicated to P. Flemming Møller's sixtieth birthday. Doctor Møller, Professor of Radiology at the University of Copenhagen and one of the original editors of the *Acta*, has been responsible for a great deal of the development and teaching of radiology in Denmark. This issue contains nineteen articles, of which all but three are in English.

All of the volumes contain such a variety of papers that it is impossible to recount their contents or even comment briefly upon their importance. Abstracts are appearing currently in RADIOLOGY and a number of the valuable Supplements are reviewed in the present issue.

The contributions of *Acta Radiologica* have enriched medicine for many years. RADIOLOGY extends greetings to this sister publication, with the earnest wish that it may be permitted to maintain its high standards and to continue to be available for the education of radiologists throughout the world.

LEO G. RIGLER, M.D.

Cystic Fibrosis of the Pancreas

With the increasing knowledge of certain disease processes and the accumulation of data by various investigators, many conditions that were previously discovered only at the postmortem table are now being diagnosed in the living with relative frequency. Among these is cystic fibrosis of the pancreas. While this has been accepted as a clinical entity, actually it is in most instances a part of a generalized process consisting in fibrosis and insufficiency of the pancreas, glandular involvement, and chronic lung changes. These last, demonstrable roentgenographically, may establish the diagnosis.

The work of Andersen (1) and of Blackfan and May (3) in 1938 did much to familiarize the medical profession with cystic disease of the pancreas as a disease entity. Their reports were the forerunners of a fairly numerous series by other workers who have added further details to our knowledge of the condition and the widespread changes associated with it.

The etiology has not yet been satisfactorily established. Some have regarded the pancreatic changes as of congenital origin, but this theory has not met with general acceptance. A familial tendency has, however, been recorded by a number of observers. The disease is essentially one of early infancy, the average age of onset in one series of 35 cases (3) being two months, with death at eight months. Some patients survive longer, in which event a diagnosis of "celiac disease" is usually made.

When death ensues shortly after birth, there is usually intestinal obstruction by thick mucilaginous meconium—so-called meconium ileus. If the child survives beyond this period, symptoms of chronic respiratory disease may so dominate the picture that the underlying condition may be missed entirely. In children living to six months or longer, the celiac syndrome—emaciation, abdominal distention, large fatty stools—becomes more obvious. At

the same time the pulmonary changes persist and may be the immediate cause of death.

Attwood and Sargent (2) have given an excellent description of the associated pulmonary lesions in cystic fibrosis of the pancreas. These consist, essentially, in a purulent bronchitis with bronchiectatic abscess formation and surrounding pneumonitis. The roentgen picture is one of infiltration throughout both lungs, decreasing toward the periphery, the greatest density occurring over the hilar areas. These changes suggest a chronic or subacute process rather than an acute one. Neuhauser (4), in a paper published in this issue of RADIOLOGY, recognizes two stages of pulmonary involvement: a pre-infection stage, which is characterized by emphysema and atelectasis secondary to obstructing phenomena, and a second stage of superimposed infection with the changes described above. Neuhauser gives, also, an excellent description of the roentgen features of meconium ileus associated with pancreatic insufficiency. With their aid, he was able to diagnose correctly 4 out of 10 cases coming to his attention.

With the better understanding of the disease made possible by the studies cited above and with greater familiarity with the roentgen findings in the chest and abdomen, as set forth by Attwood and Sargent, Neuhauser, and others, the antemortem diagnosis of fibrocystic disease of the pancreas should be made with increasing frequency.

REFERENCES

1. ANDERSEN, D. H.: Cystic Fibrosis of the Pancreas and Its Relation to Coeliac Disease: Clinical and Pathologic Study. Am. J. Dis. Child. **56:** 344–399, 1938.

2. ATTWOOD, C. J., AND SARGENT, WM. H.: Cystic Fibrosis of the Pancreas with Observations on the Roentgen Appearance of the Associated Pulmonary Lesions. Radiology **39:** 417–425, 1942.

3. BLACKFAN, K. D., AND MAY, C. D.: Inspissation of Secretion, Dilatation of the Ducts and Acini, Atrophy and Fibrosis of the Pancreas in Infants: Clinical Note. J. Pediat. **13:** 627–634, 1938.

4. NEUHAUSER, E. B. D.: Roentgen Changes Associated with Pancreatic Insufficiency in Early Life. Radiology **46:** 319–328, 1946.

5. PUGH, D. G.: Fibrocystic Disease of the Pancreas. Am. J. M. Sc. **210:** 681–687, 1945.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

The Thirty-second Annual Meeting of the Radiological Society of North America will be held at the Palmer House, Chicago, Ill., Dec. 1 to 6. The Refresher Courses will open on Dec. 1, and the General Sessions on Dec. 2.

AMERICAN BOARD OF RADIOLOGY EXAMINATIONS

The American Board of Radiology will conduct examinations at the Palmer House, Chicago, Nov. 27 to Dec. 1, 1946. This will be the only examination held during 1946. All those wishing to appear before the Board at this time must have their applications on file by Sept. 1, 1946.

B. R. KIRKLIN, M.D.
Mayo Clinic, Rochester, Minn.

THE ORLEANS PARISH RADIOLOGICAL SOCIETY

On Nov. 8, 1945, at a Roentgen celebration dinner, the radiologists of the New Orleans area formed a local radiological society to be known as the Orleans Parish Radiological Society. Dr. Lucien A. Fortier was elected president and Dr. Joseph V. Schlosser (Charity Hospital of Louisiana at New Orleans, New Orleans 13), secretary. Meetings are to be held on the first Tuesday of each month throughout the year.

PENNSYLVANIA RADIOLOGICAL SOCIETY

The next Annual Meeting of the Pennsylvania Radiological Society will be held on May 17 and 18 at the Berkshire Hotel, Reading, Penna.

LIGUE NATIONALE BELGE CONTRE LE CANCER

A request for radiological literature dealing with the cancer problem has been received from the National Belgian Cancer Society. "We beg to inform you," the letter reads, "that our association created, some years ago, a library especially devoted to the problems of cancer, which is at the disposal of the four schools of medicine of Belgium. As we were much deprived of any American medical or radiological literature during the war, we should be very glad if you would send to that library all works dealing with the cancer question published either by your Society or its members."

Such literature, including reprints, should be addressed: Ligue Nationale Belge contre le Cancer, Secrétariat-General, Rue des Deux-Eglises, 21, Bruxelles.

In Memoriam

LLOYD BRYAN, M.D.

Radiology lost one of its pioneers and successful practitioners when Lloyd Bryan died on Dec. 21, 1945. The tumor which finally brought about his end had caused a long, confining illness. Throughout the latter half of his life Dr. Bryan had suffered several illnesses through which he had come with fortitude to reoccupy his place as a leading roentgenologist in the San Francisco area.

Lloyd Bryan was born in Fortuna, Calif., on April 19, 1884. He had his academic and medical training at the University of California, from which he was graduated in 1911. He married Alice Downes of San Francisco in 1912 and spent the next four years in Eureka, as a general practitioner. Returning to San Francisco, he took a post-graduate course in roentgenology at Stanford Medical School in 1916 and then became associated with the late Howard Ruggles in the practice of radiology, which association endured until 1936. During his professional career in San Francisco, Dr. Bryan was connected with various hospitals at various times, as St. Mary's Hospital, Children's Hospital, and the University of California Hospital. His most continuous service was to the Dante Hospital, the Mt. Zion Hospital, and the San Francisco County Hospital. Dr. Bryan was a member of the faculty of the University of California Medical School for many years, being Associate Clinical Professor of Radiology at the time of his death.

Dr. Bryan was not a prolific writer but did contribute several articles to the medical journals of this country. He was a member of various societies, reaching the peak of his professional career when he was made President of the Radiological Society of North America in 1935. He was a member of his county and state medical associations and a fellow of the American Medical Association. He was a diplomate of the American Board of Radiology, a member of the Pacific Roentgen Society, the American Roentgen Ray Society, the Radiological Society of North America, and the American College of Radiology.

Dr. Bryan will long be remembered not only by his fellow radiologists but by all those with whom he came in contact. He is survived by his widow, Mrs. Alice Downes Bryan; by a daughter, now Mrs. John Martin Hanlon; a son, Dr. John Ruggles Bryan; and five grandchildren.

LT. COMDR. CECIL CHARLES WELCH, U.S.N.

Announcement has been received from the Chief of Naval Personnel of the death of Lt. Comdr. Charles Cecil Welch in a Japanese prison camp on

LLOYD BRYAN, M.D.
1884–1945

Dec. 15, 1944. Lt. Comdr. Welch received his early education in South Dakota. He was transferred from the South Dakota Medical School in 1925 to Northwestern Medical School and received his degree in medicine from that institution in 1928. He served his internship in the Navy Hospital, Boston, Mass., and his medical career was spent in the Navy. The Radiological Society of North America, of which he was a member, recognizes with pride his service to his country.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

SELECTED PAPERS FROM THE ROYAL CANCER HOSPITAL (FREE) AND THE CHESTER BEATTY RESEARCH INSTITUTE. Vol. III, 1941–1942, comprising reprints of articles from various journals. A volume of 321 pages. Price 16/-.

STUDIEN ÜBER EINIGE BIOLOGISCHE WIRKUNGEN DER RÖNTGEN- UND γ-STRAHLEN, INSBESONDERE AM PHYCOMYCES BLAKESLEEANUS. By ARNE G. FORSSBERG. Supplementum XLIX to Acta Radiologica. A volume of 143 pages, including 68 figures and tables. Published by P. A. Norstedt & Söner, Stockholm, 1943.

Book Reviews

It has been the practice of *Acta Radiologica* in years past to publish from time to time monographs dealing with various subjects of radiologic interest. A number of these appearing during the war years have only recently reached the editorial offices of RADIOLOGY. It is with pleasure that we devote the Book Review section in this issue to some of these publications.

HYSTERO-SALPINGO-PELVIGRAPHIE. By SVEN ROLAND KJELLBERG. Supplementum XLIII to Acta Radiologica. A volume of 179 pages, with 177 illustrations. Published by P. A. Nordstedt & Söner, Stockholm, 1942.

To the series of useful monographs published as Supplements to *Acta Radiologica*, Dr. Sven Roland Kjellberg of the Department of Roentgenology of the Caroline Hospital, Stockholm, has added the present volume on Hysterosalpingography. The text is in German but an adequate English summary is appended, and numerous illustrations tell their own story even to those whose knowledge of the language is limited.

The book opens with a historical review of contrast studies of the uterus and tubes, including an interesting list of some of the materials which have been used for that purpose in the last thirty-five years. The author's own material consisted of 328 cases examined in the Caroline Hospital from Nov. 20, 1940, to Feb. 28, 1942, chiefly with the aid of 50 per cent perabrodil. The examination, as he describes it, consists of two parts: first, a study of the uterine cavity and the tubal lumen; second, a study of the external contours of the pelvic organs, the thickness of the uterine wall, and the appearance of the minor pelvis. For the second part the contrast solution is diluted by an equal amount of water. Only 4 complications were seen in the entire series.

Following the discussion of anatomical considerations and the technic, are descriptions of the roentgen pictures of the normal organs and the changes incident to disease. A comprehensive bibliography, international in its scope, is appended.

THE MUSCULAR BUILD AND MOVEMENTS OF THE STOMACH AND DUODENAL BULB, ESPECIALLY WITH REGARD TO THE PROBLEM OF THE SEGMENTAL DIVISIONS OF THE STOMACH IN THE LIGHT OF COMPARATIVE ANATOMY AND EMBRYOLOGY. By JOHAN TORGERSEN. Supplementum XLV to Acta Radiologica. A volume of 191 pages, with 116 illustrations. Published by Fabritius & Sønners, Oslo, 1942.

The first part of this monograph on the structure and movements of the stomach is devoted to an excellent historical review with special emphasis on the roentgenologic studies of Forssell and the investigations of Pernkopf, who approached the subject from the point of view of embryonic development. The author has used still another method, studying the muscular structure of the stomach in specimens obtained from man and various animal species and hardened in formalin. He deals with the gastric regions separately, recording the structure, comparative anatomy, external shape, and forms of movement for each. Excellent diagrams of the various segments of the stomach are presented, showing that in reality it is a complex organ. This, in large measure, explains the functional changes, which otherwise are not easily understandable.

THE VALUE OF THE BARIUM ENEMA IN THE DIAGNOSIS AND TREATMENT OF INTUSSUSCEPTION IN CHILDREN, ILLUSTRATED BY ABOUT FIVE HUNDRED DANISH CASES. By JENS MUNCK NORDENTOFT. Supplementum LI to Acta Radiologica. A volume of 94 pages of text and 35 plates. Published by Einar Munksgaard, Copenhagen, 1943.

This monograph, the 51st of the supplements to *Acta Radiologica*, is a study of the diagnosis and treatment of intussusception in children by the use of the barium enema. It is based directly upon observations in 440 cases from Danish hospitals, though the author's experience extends beyond these so that he is able to claim knowledge of some 1,000

cases. Since the paper was summarized in a regular issue of *Acta Radiologica* and has been abstracted in RADIOLOGY (**45**: 633, 1945), its contents need not be further reviewed here.

A series of 35 plates, including 118 figures showing cases of all types, is appended to the text and there is a full bibliography.

RENAL TUBERCULOSIS AND ROENTGENOLOGIC EXAMINATION. A SURVEY AND A COMPARISON BETWEEN THE EFFICIENCY OF THE DIFFERENT DIAGNOSTIC METHODS IN SIXTY CASES OF SURGICAL RENAL TUBERCULOSIS, WITH A SPECIAL VIEW TO THE ROENTGENOLOGIC DIAGNOSTIC. By RAGNAR STEINERT. Supplementum LIII to Acta Radiologica. A volume of 162 pages, with reproductions of 35 roentgenograms, 3 graphs, and 8 tables. Published by Grondahl & Søns, Oslo, 1943.

The subtitle of this monograph on the roentgen diagnosis of renal tuberculosis as carried out in the Ullevål Municipal Hospital, Oslo, indicates adequately its scope. In the first part the historical aspects of the subject are considered, together with the various types of examination and their attendant problems. In the second part the author presents his results with intravenous and retrograde pyelography. He concludes that intravenous urography cannot replace the retrograde method unconditionally but that both may be necessary, together with inoculation and culture, to obtain an early diagnosis of tuberculosis. A detailed summary of 60 cases is included. A voluminous bibliography is appended.

CEREBRAL ANGIOGRAPHY WITH PERABRODIL (CAROTIS ANGIOGRAPHY). By ARNE ENGESET. Supplementum LVI to Acta Radiologica. A volume of 207 pages, with 68 illustrations. Published by Fabritius & Sønners, Oslo, 1942.

This monograph from the Roentgenologic and Neurological Departments of the University Clinic of Oslo is based on a study of 100 patients on whom cerebral angiography was performed, with 35 per cent perabrodil, introduced intra-arterially, as the contrast medium. In the series were 56 cerebral tumors, of which 47 were localized by angiography. In 14 cases there were pathologic changes in the vascular supply of the tumor and in 33 cases there was vascular displacement. There were discovered, also, 5 saccular aneurysms and 3 of the arteriovenous variety. Thrombosis of the carotid and subdural hematoma may also be demonstrated. Sixty-eight case histories are included, with numerous illustrations. Those interested in cerebral angiography will find this a valuable study.

URETHROCYSTOGRAPHY IN THE MALE WITH SPECIAL REGARD TO MICTURITION. By NILS P. G. EDLING. Supplementum LVIII to Acta Radiologica. A volume of 144 pages, with 66 illustrations. Published by P. A. Norstedt & Söner, Stockholm, 1945.

At the Roentgen Diagnostic Clinic of the Karolinska Sujkset, from which this monograph comes, examination of the lower urinary tract has taken the form of urethrocystography, based on concurrent filling of the urethra and bladder with contrast material. The earlier practice was to make retrograde studies only, but since 1940 these have been supplemented by examination during micturition. The author has made a critical analysis of the relative value of these two methods in the study of normal and pathologic conditions of the bladder and urethra, concluding that micturition studies form an important complement to the retrograde method and that if the greatest amount of information is to be gained both should be employed.

ON CANCER OF THE BREAST, WITH SPECIAL REFERENCE TO THE RESULTS OF DIFFERENT METHODS OF TREATMENT. By STURE RÖDÉN. Supplementum LVII to Acta Radiologica. A volume of 50 pages, with 42 tables. Published by P. A. Norstedt & Söner, Stockholm, 1945.

This small but useful monograph comes from the First Surgical Clinic of the Caroline Institute, Stockholm. The author surveys the results of treatment of carcinoma of the breast by (1) surgery alone, (2) surgery and postoperative irradiation, and (3) preoperative irradiation, surgery, and postoperative irradiation combined. He cites the results of surgeons and radiologists, both American and European, and presents his own material. The difficulty of making comparisons is mentioned and it is rightly stated that indisputable conclusions cannot be drawn from comparisons of this sort.

The author's series consists of 343 cases. These patients were uniformly operated upon; the follow-up reached 99 per cent, and histologic diagnosis was obtained in more than 97 per cent of the number. The five-year survival rate for the entire series was 46.9 per cent. The author concludes that the best results are obtained by use of surgery with preoperative and postoperative irradiation. The statistical analysis is detailed, and much other interesting and related information is contained in the monograph.

RADIOLOGICAL SOCIETIES OF NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

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PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

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Dallas-Fort Worth Roentgen Study Club.—Secretary, X. R. Hyde, M.D., Medical Arts Building, Fort Worth 2 Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

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La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meets on third Saturday of each month.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meets monthly.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Aerosinusitis: A Clinico-Roentgenological Study. Martin Schneider. Am. J. Roentgenol. **53:** 563–572, June 1945.

Aerosinusitis is a distinct clinical entity closely allied to aero-otitis media. It occurs during descent from altitude in an aircraft or altitude chamber. It is characterized clinically by a sudden, severe, unremitting pain localized over the region of the affected sinus. It is thought that the pain is due to sudden stretching and separation of the mucoperiosteum following the developing of high negative pressure as a result of plugging of the ostium by a mucous plug or other cause. Roentgenograms demonstrate the mucoperiosteal swelling and may show the presence of fluid, which can be either a simple transudate or a hematoma. Without an adequate history, the roentgen appearance is hardly distinguishable from the changes seen in acute allergic or infective sinusitis. L. W. PAUL, M.D.

Roentgen Diagnosis of Malignant Tumors Within the Boundary Region Between the Pharynx and Esophagus. Åke Åkerlund and Sölve Welin. Acta radiol. **25:** 883–911, Nov. 21, 1944. (In English.)

Roentgen demonstration of malignant tumors within or adjacent to the entrance of the esophagus is possible at a stage when laryngoscopic findings are still negative. Any patient, therefore, in whom such a tumor is even slightly suspected should have the advantage of roentgen studies. This method of examination is simple and harmless, without inconvenience to the patient. It permits an evaluation of the depth of the lesion in the pharyngo-esophageal wall and thus furnishes valuable information for the planning and application of radiotherapy. It also assists in the early diagnosis of possible regional recurrences.

From Feb. 1, 1940, to May 1, 1944, 48 patients with cancer in the region between the pharynx and esophagus were examined in the Department of Diagnostic Roentgenology at the Caroline Hospital, Stockholm. In 29 of these cases, the laryngoscopic findings were either completely normal or at least not sufficiently characteristic to warrant a clinical diagnosis of tumor. In 28 of these cases, roentgenography furnished conclusive evidence of a neoplastic growth even on the first examination. The roentgenologic appearance, technic, symptomatology, and differential diagnosis are described in detail.

Arthrography of the Mandibular Joint. Flemming Nørgaard. Acta radiol. **25:** 679–685, Nov. 21, 1944. (In English.)

The author describes the technic employed in 34 instances of mandibular arthrography (in 28 patients) with the aid of an aqueous iodine solution as a contrast medium.

Solitary Myeloma of the Frontal Bone. Charles W. Schwartz. Am. J. Roentgenol. **53:** 573–574, June 1945.

A case is reported of solitary myeloma of the skull occurring in association with Paget's disease. This is the seventh case recorded in the literature of skull involvement by this tumor. The patient, a 42-year-old female, complained of indefinite headache for four years. Roentgen examination showed the characteristic changes of Paget's disease. There also was a sharply circumscribed area of rarefaction in the left posterior frontal bone. The biopsy diagnosis of this lesion was a giant-cell myeloma. Roentgen therapy was given, a total of 1,274 r in eight days. The mass gradually regressed and the defect filled in with bone.

L. W. PAUL, M.D.

Fracture of the Atlas: Review and Presentation of Data on Eight Cases. John J. Hinchey and William H. Bickel. Ann. Surg. **121:** 826–832, June 1945.

The authors cite 112 cases of fracture of the atlas, including 8 of their own. In 50, the lesion was an isolated one, involving the atlas alone, while in 62 it was complicated by other injuries, such as fractures of the vertebrae or skull. The mortality rate was 10.7 per cent.

Fractures of the atlas are almost always due to trauma to the top of the head when the spine is in a neutral position. The site of predilection is the posterior arch, since this is weakened by the grooves for the vertebral arteries while the occipital condyles, facing posterolaterally, tend to splay the atlas out in those directions. The anteroposterior view may show a gap in the anterior arch, as well as an outward displacement of the lateral masses, while the lateral view readily demonstrates fractures of the posterior arch. Swelling of the soft tissues in the prevertebral space may mean fracture of the anterior arch, while an increase of the distance between the anterior arch and the odontoid process may indicate rupture of the transverse ligament or dislocation.

Treatment consists of traction followed by application of a plaster encasement or a leather collar. In the 8 cases reported by the authors, the posterior arch alone was fractured in 5 cases, the posterior and anterior arches were fractured in 2, and the articular facet was fractured in the remaining case. Two cases were complicated by fractures of additional bones. The results were classed as excellent in 3 cases, good in 2, fair in 2, and poor in one. There were no deaths in this group.

ELLWOOD W. GODFREY, M.D.

THE CHEST

On the Influence of the Intra-Alveolar Pressure on the Normal and Pathological Structure of the Lungs. Nils Westermark. Acta radiol. **25:** 874–882, Nov. 21, 1944. (In English.)

On comparing pulmonary roentgenograms taken under normal pressure with those obtained at low pressure, it is found that the films taken at a low pressure demonstrate a considerably increased filling of the vessels in the lungs, an increased structure, and a larger cardiac volume. Roentgenograms taken under high pressure, on the other hand, when compared with films taken under normal pressure, show a considerable reduction in the filling of the vessels and a diminution in their structure and in the cardiac volume Films taken under high pressure reveal a definite difference in pulmonary stasis, pulmonary edema, and in acute pneumonic changes. By routinely taking chest films under normal and high pressures, therefore, a more exact and

safer diagnosis can be made in such conditions. In chronic inflammatory conditions and tuberculosis there are no changes, or at least none so striking as in acute conditions.

At the St. Göran Hospital, where 1,500 persons with pulmonary changes have now been examined by this method, a water manometer is used, employing a normal pressure of −5 to −10 cm. water. Immediately before the film is taken, the patient is told to make a light inspiration and then to suck through the mouthpiece until the level of the liquid falls so that there results a pressure of −5 to −10 cm. water. To obtain films exposed at a low pressure, inspiration is augmented until a low pressure of −40 cm. water is reached. To obtain pictures with high pressure, the patient must press the water level of the manometer up to 40 cm. These are the pressures employed in routine examinations. If on any occasion another pressure is used, this is indicated separately.

Radiology of War Injuries. Part III. War Wounds of the Chest. D. B. McGrigor and Eric Samuel. Brit. J. Radiol. **18:** 133–145, May 1945.

In modern warfare the radiological investigation of chest wounds falls into two main classes. In the *forward areas* the examination is usually confined to scout films to give a general estimation of the intrathoracic damage. More complete studies, including fluoroscopy, are done at *base hospitals*. Periodic examinations during convalescence are most important, especially where re-expansion of the lung is being followed. A suggested radiological classification of chest injuries includes four main headings: non-penetrating injuries, penetrating injuries, empyema, heart injuries.

Non-Penetrating Injuries: Fractures of the ribs usually occur as the result of anteroposterior compression, though below the seventh they may be due to muscular exertion. The fragments rarely penetrate the lungs. Rib fractures may be overlooked at the primary examination, and re-examination should be made in about ten days. Fractures of the spine, sternum, shoulder girdle, and scapula should always be looked for in chest injuries.

Extrapleural hematoma and edema of the chest wall may give rise to confusing shadows. They may follow any type of chest injury. They usually can be differentiated by the fact that the bronchovascular markings and the hilar shadow are undisturbed.

A segment of the chest wall, by reason of double fracture of the ribs, may become functionally detached from the rest of the wall, resulting in a "stove-in" chest. This produces symptoms similar to an open pneumothorax. Roentgenograms usually reveal a hemopneumothorax or a large hematoma of the chest wall. Considerable emphysema may occur. Massive collapse is sometimes observed.

Atelectasis most frequently follows bronchial obstruction either from mucus or blood. It may be segmental or total, depending upon the size of the bronchus occluded. Since stricture of the bronchus may follow, serial examinations are important.

Blast injuries produce mottling in the periphery and lower lung fields. Lobular and lobar collapse may also be present. There may be localized emphysema of the upper lobes. In simple cases clearing is observed in three days and the chest will appear normal in about ten. Hematomas in the lung may follow blast or other non-penetrating injuries. These are identified as central opacities with ill-defined borders. Resolution takes place in six to eight weeks.

Mediastinal emphysema is serious when it is caused by rupture of a bronchus, but when secondary to spontaneous pneumothorax it is not significant. Engorgement of the vessels of the head and neck and of the pulmonary circulation is common, due to pressure on the veins. A lateral film reveals the air in the mediastinum, while a postero-anterior view shows a clear linear area along the lateral borders of the heart.

Traumatic asphyxia is seen after sudden compression of the chest. The clinical picture is characteristic. Radiographically lobular collapse of the lung may be observed. The condition usually follows a benign course. Retinal hemorrhages may be a serious complication.

Fat emboli following fracture of the larger bones may produce a bizarre appearance, multiple areas of density resembling bronchopneumonia, which disappear in a few days.

Penetrating Injuries: In the presence of foreign bodies radiology is used for their anatomical localization, for investigation of the pathological state with reference to surgical approach, and for the estimation of the damage along the track of the missile. Localization of a foreign body demands careful fluoroscopy. Tangential views are often useful. Foreign bodies in the heart may not be visible because of the motion. Foreign bodies more than 1 cm. in diameter should be removed because they are likely to carry with them infected material, such as parts of clothing.

Seventy-five per cent of the penetrating wounds of the chest are associated with hemothorax, and some 80 per cent of these cases become infected. The radiological signs are those of pleural effusion. The blood should not be left in the thorax for an undue length of time. Clotting or organization of a hemothorax is suggested by mottling, multiple fluid levels, thickening of the visceral pleura (if an associated pneumothorax is present), and mediastinal displacement toward the affected side.

Tension pneumothorax is readily diagnosed, though it may be confused with traumatic diaphragmatic hernia, large emphysematous bullae, and giant cysts of the lungs.

In abdomino-thoracic wounds rupture of the diaphragm is indicated by the invisibility of the dome either because of retraction of the sides of the tear or the presence of hemorrhage. At the screen intermittent twitching movements may be seen. There may be atelectasis with little blood in the pleural cavity. It is important in these wounds to know the point of entrance and exit of the missile. There are three main types of missile track demonstrable radiologically: a hollow track, a solid track, and a track marked by traces of metal.

Empyema: Empyema occurs in about 20 per cent of serious wounds of the thorax. In chronic cases overpenetrated and grid films are useful. Iodized oil may frequently aid in determining the size of the cavity. Tomography is useful for the same purpose.

Heart Injuries: Careful fluoroscopy is essential in localizing foreign bodies in the heart. The relation of the foreign body to the various motions of parts of the heart is important.

Death following chest injury may be due to "cardiac tamponade." In the acute type there is rapidly developing intrapericardial tension. An insidious

type may develop where there is a foreign body near the heart. The diagnosis can best be made fluoroscopically by the restriction or complete absence of pulsation. This should be looked for in all patients where the distress is out of proportion to the evidence of injury. SYDNEY J. HAWLEY, M.D.

Pathological Manifestations and Anatomical Variations in Pre-Enlistment Chest Roentgenograms. F. G. Stuart. Canad. M. A. J. **52:** 477–481, May 1945.

The author reports observations on 19,000 chest roentgenograms made during a forty-eight week period in 1943 on Canadian Army recruits (males) between eighteen and thirty-eight. Of this group, 6 per cent showed the calcified nodules of Ghon. These were found fairly equally distributed throughout both lung fields in contrast to the re-infection type of tuberculosis, which predominates in the upper thirds of the lung fields. By actual count, there was a larger number of these calcified nodules in the hilar areas than in the peripheral zones, indicating that some of the peripheral lesions had completely disappeared.

Re-infection type of tuberculosis was found in 237 or 1.3 per cent of the series and varied from minimal to far advanced lesions.

Obliteration of the costophrenic sinus was observed in 648 or 3.4 per cent. In the majority of these patients, no history of significant respiratory disease could be elicited. It was found, however, that obliteration of the costophrenic sinus occurred three and one-half times more frequently in those showing the calcified primary complex than in those that did not.

In 42 of the series, non-tuberculous atypical pneumonia was found, but none of this group had any clinical evidence of the disease. The infiltration in these cases was almost invariably in the lower half of the lung fields.

Studies of the cardio-thoracic ratio were also made. It was found that if the cardiac diameter did not exceed 50 per cent of that of the chest, the chances for cardiac disease are only one in seventy, but in those cases where the cardiac diameter exceeds 50 per cent, the chances for cardiac disability are one in two. Notation was also made of various congenital anomalies, and the ratios of these are given. Dextrocardia was noted in 4 cases, or one in 4,762. Other anomalies are listed, but are too numerous to mention here.

Finally, the author discusses technical positioning for chest radiography to study completely the upper part of each lung field. If questionable lesions are seen in routine projections, two additional exposures are made: one anteroposterior with the patient in the lordotic position, the primary beam being projected parallel to the plane of the first rib; the other posteroanterior with the beam angulated downward and the central ray projection through the apical area. By using a film blocker, both of these projections can be made on one 14 × 17-in. film, since the whole of such a film is not needed for either view.

BERNARD S. KALAYJIAN, M.D.

Tuberculosis in World War II (Symposium). Council on Military Affairs and Public Health, American College of Chest Physicians. Dis. of Chest **11:** 266–281, May–June 1945.

This symposium, presented before the American College of Chest Physicians, consists of reports from the medical government agencies on the problem of tuberculosis control.

Maj. Gen. Shelley U. Marietta, representing the Army, stated its problem as the elimination of those with tuberculosis and those with inactive lesions which might be re-activated under stress, and prevention of rejection of those with minimal lesions not considered hazardous. It was agreed that the most rapid and accurate method of deciding these factors was by means of properly taken and properly interpreted x-ray films of the chest. Arbitrary standards, based on x-ray findings, were set up for guidance for various boards of examiners. This resulted in a general rejection rate of 1 to 1.5 per cent of all men examined. Despite precautions, a considerable number of tuberculous individuals were inducted because of improper interpretations by inexperienced roentgenologists or other causes. The record, however, is not too bad, for the average admission rate for tuberculosis is 1 per 1,000; during World War I it was 11.8 per 1,000. This difference is attributable to the better methods now in use to discover cases.

Capt. Robert E. Duncan stressed the decreasing incidence of tuberculosis in the Navy and the extensive use of photofluorographic studies as a case-finding procedure in its tuberculosis control program.

Col. J. D. Adamson stated that over one and a half million prospective members of the Canadian forces have been x-rayed and examined for tuberculosis, a figure which represents 26 per cent of the male population and 63 per cent of males of army age. In 1 per cent significant disease was found.

Col. Roy A. Wolford, Assistant Medical Director of the Veterans' Administration, presented a statistical study of tuberculosis cases among World War II veterans. In all hospitals, through March 1944, admissions of tuberculous veterans having service after Dec 7, 1941, approximated 7,200, of which some 4,200 had been discharged, leaving almost 42 per cent of the World War II tuberculous veterans in the hospitals on March 31, 1944.

Dr. Joseph W. Post, speaking from the point of view of the radiologist, expressed his opinions based on experience with examination of army inductees and in a tuberculosis clinic in Philadelphia. He was enthusiastically in favor of mass surveys, favoring 35-mm. films, with conventional films for suspicious cases. The photofluorographic examinations are reliable, and early and minimal lesions are detectable when the films are viewed and interpreted by competent radiologists. Dr. Post objected to the evaluation of a tuberculous lesion on a mathematical basis, *i.e.*, the size of calcified nodes or the number of calcified foci in a given area. The importance and value of the screening process is attested to by the fact that tuberculosis, the chief cause of disabilities leading to discharge in World War I, dropped to tenth place in World War II.

Dr. Herman E. Hilleboe and Dr. David M. Gould of the U. S. Public Health Service discussed tuberculosis control in industry. HENRY K. TAYLOR, M.D.

The Chest X-Ray Examination: Analysis of Disqualifying Conditions Found Among 105,141 Selectees. Richard E. Kinzer. J. A. M. A. **128:** 499–502, June 16, 1945.

When the results of x-ray chest surveying of a sizable group of draftees were tabulated, it was found that 1.26 per cent of 105,141 persons were rejected for military

service because of abnormal chest findings. Rejections because of some form of tuberculosis as discovered by the x-ray survey represented 0.95 per cent of the total group examined. Among the tuberculosis cases, those with signs of minimal re-infections predominated, 526 of the 999 selectees who were rejected.

These figures once again illustrate the practical value of the x-ray screening process without presuming that any single method of examination will be found to be infallible. Unfortunately the notoriously poor quality of x-ray reproductions provided by the J. A. M. A. forced the author to use as illustrations only the more obvious examples of pulmonary disease.

The discussion of Major Kinzer's paper by Dr. Robert Bloch contains interesting arguments for the employment of fluoroscopy as a case-finding method. Not all radiologists will agree entirely with Dr. Bloch's views.

FRED JENNER HODGES, M.D.
(University of Michigan)

Miniature Chest X-Ray Films in General Hospitals. George N. Scatchard and Diana O. Duszynski. J. A. M. A. **127:** 746–748, March 31, 1945.

An analysis of 3,000 consecutive chest roentgenograms taken at the Edward J. Mayer Memorial Hospital, Buffalo, during approximately two and one-half summer months, illustrates the importance of routine x-ray examination of the chest of every patient on admission. This figure includes follow-up studies and reexaminations as well as new admissions. Of the 3,000 examinations 1,070 (35.7 per cent) revealed significant lesions. Conventional films were used in 326 studies, miniature films in 2,721 (90.7 per cent), and a combination of the two methods in 47. During the period of this study 1,832 patients were admitted to the hospital and in this group 36 unsuspected cases of pulmonary tuberculosis were discovered by roentgenography. Twenty-six were from 725 new admissions, representing 3.6 per cent of unsuspected pulmonary tuberculosis. The authors believe that stereoscopic photoroentgenography is an economical and satisfactory method.

Nontuberculous Lesions Found in Mass X-Ray Surveys. David M. Gould. J. A. M. A. **127:** 753–756, March 31, 1945.

The discovery of non-tuberculous pathologic changes has been a valuable by-product of mass surveys primarily intended for tuberculosis case finding in industry. An analysis of 442,252 chest films revealed a total of 4,982 cases (1.1 per cent) showing evidence of nontuberculous chest disease. Sixty-six different lesions are listed according to the frequency of occurrence. A large proportion of abnormalities were unknown to the patients prior to the x-ray examination. The lesions are classified in three main categories: (1) chest abnormalities frequently resembling pulmonary tuberculosis; (2) chest abnormalities infrequently resembling pulmonary tuberculosis, including parenchymal lesions, mediastinal, pleural, and diaphragmatic lesions, cardiovascular lesions, systemic disease as evidenced on the chest film; (3) miscellaneous and bizarre findings.

Tuberculosis, a New Post War Public Health Problem. Edward A. Piszczek. Illinois M. J. **87:** 284–291, June 1945.

The author discusses the public health and case-finding aspects of tuberculosis, particularly as they relate to the state of Illinois. The death rate from tuberculosis has shown an increase during the war, as it did during and following World War I.

Illinois has lagged behind a number of other states in decline of tuberculosis during the period 1930–1942. This is attributed to shortage of sanatorium facilities and to inadequate case-finding surveys. More extensive survey of the population by x-ray examination, using 4 × 5-inch film, is advocated in order to discover more cases of tuberculosis in the minimal stages. Reference is made to the experience of the Armed Forces in examination of some 12 million inductees. Sixty per cent of the cases found by this method were in the minimal stage and did not require hospital treatment.

H. H. WRIGHT, M.D.

Bronchography in Pulmonary Tuberculosis: A Geographical Adventure. B. A. Dormer, J. Friedlander, and F. J. Wiles. Am. Rev. Tuberc. **51:** 455–462, 519–526, May and June 1945.

This is the fourth paper in a series dealing with bronchography (the earlier ones are abstracted in Radiology **44:** 603, 1945; **45:** 412, 1945). It describes the appearance of the bronchial system in pulmonary tuberculosis. Experience has shown that tuberculosis is a disease which does its greatest harm to the bronchial system and that, even in early stages of the disease, irreparable damage may be done to the bronchial tree. Block of some portion of the bronchial system is invariably present in every case unless the area beyond the block has already broken down into a cavity. As a result of bronchial or bronchiolar block, there occurs cavitation or bronchiectasis and ultimately a distortion of the bronchial tree due to fibrosis. Tuberculous cavitation and bronchiectasis, therefore, arise in exactly the same way as does non-tuberculous bronchiectasis or pulmonary abscess.

Sixteen case reports are presented with reproductions of roentgenograms to illustrate these concepts. The cases include various pathologic types of pulmonary tuberculosis and demonstrate the use of bronchography in mapping the bronchial tree. Several cases of nontuberculous bronchiectasis are included to show the similarity of the bronchial damage to that occurring in tuberculosis.

L. W. PAUL, M.D.

Roentgenology of the Massive Conglomerate Lesions of Silicosis. Mortimer R. Camiel. Am. Rev. Tuberc. **51:** 527–531, June 1945.

In chest roentgenograms, the massive conglomerate lesions of silicosis are frequently confused with pulmonary cancer, infections, or atelectasis. There is, however, a group of these conglomerate silicotic lesions which produce so typical a roentgenologic picture that the diagnosis can be made from the roentgenogram alone. The basic appearance of the lung in this type of the disease is described as follows:

1. Subapical or subclavicular location of the lesions is most common; the process is often located in the apices of the lower lobes.
2. The lesions are almost invariably bilateral.
3. There is a tendency toward symmetry.
4. There is frequently a clear zone of emphysema surrounding the lesions and separating them from both the hila and the chest wall. The separation from the hila is an important sign, since it excludes at once lesions which might arise in the hilar lymph nodes, such as Hodgkin's disease.

5. Emphysema over the remainder of the lung fields is almost invariably present.

6. The position of the lesions is usually longitudinal. Gardner points out that they may lie at right angles to the ribs. The shapes of these lesions do not form standard patterns, as may be seen with neoplasms or infarction, but their longitudinal position is helpful in recognition.

7. Confirmatory typical nodulation may be present.

8. The lesions in the separate lung fields incline toward a similar density and appearance. With primary carcinoma or tuberculosis on one side with spread to the other, the appearance in the opposite lung field is different. The density may be much greater than with neoplasms.

9. Fibrous strands are frequently seen radiating outward from the lesions.

10. Diaphragmatic deformities are frequent. Limitation of diaphragmatic motion is common.

11. The trachea is usually in the mid-line.

Two cases are reported to illustrate these changes.

L. W. PAUL, M. D.

Case of So-Called Lung Cyst, Apparently a Subpleural Interstitial Airspace. Jan Nordenskjöld. Acta radiol. **25:** 662–671, Nov. 21, 1944. (In German.)

The author reports a pulmonary cyst in a 7-year-old girl. The cyst, measuring 7.5 × 7.5 × 8.0 cm., with a wall 1.0 mm. thick, in the left lower lobe, was an incidental finding during a respiratory infection. The sputum was negative for tuberculosis. On needling the cyst, clear yellow fluid was obtained containing pus cells and Gram-positive diplococci, but no tubercle bacilli. There was no change in status for about three years, but eventually an excision led to a bronchial fistula; finally a thoracoplasty was necessary. The patient was in good condition on discharge.

The author believes this was an interstitial subpleural emphysematous bleb developing as a result of whooping cough. He discusses at length the pathological physiology by which such a condition can be produced.

LEWIS G. JACOBS, M.D.

Studies on the Roentgen Findings in Intracardiac and Particularly Perimitral Calcifications. Henning Odqvist. Acta radiol. **25:** 686–700, Nov. 21, 1944. (In German.)

Cardiac calcifications are fairly common, failure to demonstrate them more frequently on roentgenograms being due to technical factors. For a long time fluoroscopy was the only successful method but, with the development of high-speed technics, film demonstration has become possible.

Mitral calcifications appear in two forms. In cases due to endocarditis, commonly found in younger patients, the calcification takes a rounded contour with a beaded configuration; when a single valve is involved, the structure may be coarsely streaky and patchy. In degenerative conditions the annulus calcifies in the shape of a horseshoe in the mitral region, particularly at the attachment of the posterior leaf. More rarely a ring is formed. Limited motion of the leaves indicates impaired cardiac action. This type of change is more common in people in the sixties.

The finding of these calcifications requires special fluoroscopic technic. The fluoroscopist must be perfectly accommodated, preferably for over an hour, and must use great care in the search. The use of hard rays is advisable. Fluoroscopy in the sagittal direction demonstrates the calcifications more clearly. The use of such calcifications in the study of heart action is discussed, and some illustrative cases are recorded.

LEWIS G. JACOBS, M.D.

Disseminated Calcified and Bony Nodules in the Lungs Associated with Mitral Disease. A. Grishman and I. J. Kane. Am. J. Roentgenol. **53:** 575–581, June 1945.

Eight cases of disseminated bony and calcific nodules in the lung occurring in association with mitral stenosis and insufficiency are reported. The pathogenesis of these lesions is unknown. The clinical histories suggest that they have their origin during rheumatic fever and the early lesions preceding calcification probably develop then. The calcific shadows may be insignificant in size and number and easily overlooked or may be extensive. They are found predominantly in the basal lung areas and vary considerably in size. They are apt to be called "healed miliary tuberculosis," but the authors believe this is infrequent and some doubt its existence altogether. Hematogenous dissemination of tuberculosis involves chiefly the upper lung fields. The final differentiation from tuberculosis is based upon the basal distribution of the lesions, absence of other tuberculous lesions elsewhere, and the presence of mitral stenosis and insufficiency. L. W. PAUL, M.D.

Roentgenologic Determination of Heart Volume in Infants. A Preliminary Report. Oliver Axén and John Lind. Acta paediat. **32:** 270–287, 1945. (In English.)

Roentgen determination of the heart volume was carried out in 45 infants with normal hearts. Films were taken simultaneously in two planes at right angles (the frontal and sagittal planes) and the volume computed by Jonsell's modification of the Kahlstorf formula (Jonsell: Acta radiol. **20:** 325, 1939). With this method, the area of the frontal heart shadow is calculated by the formula for an ellipse.

In order to ascertain the error of the method, a number of control examinations were made on cadavers, and in addition double determinations were made in 18 infants at the time of the roentgen examination. The absolute values from the heart volume were correlated with the body length and the body weight, and the heart volume per square meter of body surface with the body length.

THE DIGESTIVE SYSTEM

Analytical Survey of 1,132 Patients Gastroscopically Examined. Leo L. Hardt, A. Ray Hufford, and J. I. Rabens. Gastroenterology **4:** 477–483, June 1945.

During the period 1940–43, inclusive, 1,132 patients were examined gastroscopically one or more times in three institutions in Chicago. All of these patients had symptoms of gastroduodenal disease.

The stomach was found to be normal on gastroscopic examination in 439 (38.7 per cent) cases. Of this group, 244 were roentgenologically normal and 195 had x-ray findings indicative of duodenal ulcer. The gastroscopic and roentgen reports agreed on the absence of organic disease in 411 cases. In the remaining 28 patients, the roentgen diagnosis was indeterminate and indefinite

for gastric disease. Suggestions of pyloric deformity and possible carcinoma were made, but subsequent observations proved these diagnoses to be incorrect.

In 285 patients (24.8 per cent) a gastroscopic diagnosis of gastritis was made. Acute gastritis was diagnosed gastroscopically in 52 cases; the roentgen findings were normal in these patients. Atrophic gastritis was found on gastroscopic examination in 145 patients, and in 87 of these there was an evident vitamin deficiency. The roentgen findings were normal in 112 of the 145 cases, and in 25 a diagnosis of duodenal ulcer was made. Hypertrophic gastritis was diagnosed gastroscopically in 69 patients. Roentgenograms revealed hypertrophic changes in 2 of this group; the findings were reported as normal in 26 cases, indicative of duodenal ulcer in 19, and as showing a pyloric deformity or questionable gastric ulcer in 9.

Benign gastric ulcer was diagnosed clinically, roentgenologically, and gastroscopically in 193 patients. The diagnosis was made gastroscopically in 171 patients, and roentgenologically in 111. Fourteen patients had marginal (gastrojejunal) ulcers, as shown by the combined use of gastroscopy and roentgenology. The ulcer was visualized gastroscopically in 11 patients and roentgenologically in 6.

A diagnosis of gastric cancer was made in 136 patients. Of the 79 patients in whom a cancer was found on surgical exploration, the gastroscopic diagnosis proved correct in 73, the roentgen diagnosis in 61.

The gastro-enterostomy stoma of 34 gastro-enterostomized patients was visualized gastroscopically in 29 instances and roentgenologically in 30. Of 2 gastric diverticula demonstrated roentgenologically, only one was detected with the gastroscope. Gastric polyps were found gastroscopically in 11 patients; in 4 of these patients the roentgen diagnosis was a questionable carcinomatous lesion and in 3 a duodenal ulcer. Four roentgenograms were entirely normal.

Gastroscopic examination was incomplete or unsatisfactory, for various reasons, in 58 of the 1,132 patients.

On the basis of their experience, the authors conclude that gastroscopy is indicated (*a*) in all cases of persistent or recurrent gastric complaints with negative roentgen findings, in which gastric disease is still suspected; (*b*) in many cases of proved gastric ulcer where operation is not performed; (*c*) in cases where the x-ray findings indicate a suspicious gastric lesion or a definite diagnosis cannot be made; (*d*) in all cases of cancer of the stomach except those in which the lesion is located at the cardia or is well advanced.

On Gastrospasm and Its Roentgenologic Appearance. Carl Sandström. Acta radiol. **25:** 765–795, Nov. 21, 1944. (In English.)

The term gastrospasm is used by the author to denote a functional tetanic cramp in the wall of the stomach due to the structure of the muscular coat, without evidence of organic change such as gastritis, ulcer, or tumor. Roentgenologically gastrospasm is characterized by a more or less pronounced deformity of the stomach, of a retort- or cascade-type, with rigid contours. Gastric peristalsis is weakened or completely halted, the motility of the stomach is reduced, and the emptying time disturbed. Changes in the deformity during examination, with complete return to normal upon subsequent control examination, are pathognomonic of the condition. The author discusses the roentgenological differential diagnosis of gastrospasm and presents, on the basis of the roentgen anatomy of the stomach, a tentative anatomical explanation of the deformity. Etiology and therapy are also discussed. Four cases are presented.

Hypertrophic Gastritis Simulating Gastric Carcinoma. H. Marvin Pollard and Ralph R. Cooper. Gastroenterology **4:** 453–465, June 1945.

While confusion between the roentgen manifestations of gastric carcinoma and those of a localized hypertrophic gastritis is rare, a number of cases are on record indicating that such a problem does exist.

During the past four years, at the University Hospital, Ann Arbor, Mich., roentgen examination of the stomach in 8 cases revealed a filling defect not distinguishable from cancer. All of the patients were males, ranging in age from twenty-two to sixty-five. In 5 of the 7 cases in which gastroscopy was done, a diagnosis of localized hypertrophic gastritis was established with reasonable certainty. The diagnosis of hypertrophic gastritis and the absence of neoplasm were confirmed in 7 of the 8 cases by laparotomy, and histologically in 6.

Since early diagnosis and treatment are essential in the management of gastric neoplasm and operation may be contraindicated in cases of hypertrophic gastritis, it seems important that all such cases be studied gastroscopically before surgery is undertaken. It is perhaps wiser not to depend on a trial of conservative therapy to establish the diagnosis.

Neither roentgen nor gastroscopic findings alone are sufficient to distinguish between localized hypertrophic gastritis of the lower regions of the stomach and annular neoplasm in that area.

[It is unfortunate that the roentgenograms which accompany this paper have no legends or dates and there are no references to them in the text, so that it is difficult in some instances to correlate them with the case histories.]

Pernicious Anemia and the Early Diagnosis of Tumors of the Stomach. Leo G. Rigler, Henry S. Kaplan, and Daniel L. Fink. J. A. M. A. **128:** 426–432, June 9, 1945.

Roentgen examination of the stomach of 211 patients with pernicious anemia revealed a cancer in 8 per cent and benign polyps in 7.1 per cent of the cases. In approximately 20 per cent of the cases only one examination was made, usually at the time of the discovery of the anemia. In the remaining 80 per cent there were multiple examinations, usually semiannually but often at longer intervals. In some instances as many as eight roentgen examinations of the stomach were made. Pains were taken to reveal not only cancer but also benign polyps. In an autopsy series published elsewhere (Am. J. M. Sc. **209:** 339, 1945) Kaplan and Rigler found 12.3 per cent of patients with pernicious anemia to have cancer of the stomach as well. The high incidence of cancer revealed by these studies indicates clearly an etiologic rather than an accidental relationship between pernicious anemia and gastric tumors.

The routine roentgen examination of the stomachs of patients with pernicious anemia has proved to be a

valuable procedure, resulting in some salvage of cancer cases which might otherwise not have been obtained.

Cases illustrating the rapid change from a benign polyp to a cancer, the presence of benign and malignant tumors side by side, the absence of symptoms in the presence of large tumors, and the development from a small, barely detectable lesion to an extensive inoperable carcinoma were observed.

Pneumothorax Resulting from a Dissecting Gastric Ulcer: Review of the Literature and Report of a Case. Perry B. Hudson, Lendall C. Gay, and Howard E. Newman. Arch. Surg. **50:** 301–303, June 1945.

Acquired gastrothoracic fistula resulting from peptic ulcer is a rare condition; the authors could only find 25 previous reports. Their case is one in which an acute type of ulcer burrowed through the gastric and esophageal walls, with perforation into the left thorax. The abdominal cavity remained unsoiled. Fluid removed by thoracentesis was proved to be gastric contents. No operation was undertaken, and the patient died about twenty-one hours after onset of acute symptoms; it was believed that no surgical procedure could have been effective. LEWIS G. JACOBS, M.D.

Duodenal Ulcer in a Large Army Camp: Incidence and Statistical Analysis. Horace B. Loder and Stanley A. Kornblum. Mil. Surgeon **96:** 492–497, June 1945.

In a series of 1,702 patients with abdominal complaints at a large army camp, the history and symptoms warranted roentgen investigation of 394 (23.15 per cent). One in every 4 of those examined by x-ray had organic disease (95 patients) and one in every 5 (82 patients) had active duodenal ulcer. No gastric ulcers or perforated duodenal ulcers were found in this series. Gastric analyses were of no aid in differential diagnosis. There was no appreciable difference in the incidence of duodenal ulcer in the white and Negro soldier. Fifty-six (68.29 per cent) of the patients with duodenal ulcer had symptoms prior to going on active duty. Many of the soldiers with duodenal ulcer presented atypical and psychosomatic complaints.

Case of Trichobezoar. Gösta Gråberger. Acta radiol. **25:** 504–506, Nov. 21, 1944. (In German.)

The author reports the case of a 4-year-old girl who had been addicted to eating her own hair for about a year. The presenting symptom was an epigastric mass the size of a fist. Roentgen examination of the stomach showed the presence of a typical bezoar; the pylorus remained constantly open during roentgenoscopy. At operation the bezoar was found to be of hair and to have a "tail" which extended through the length of the duodenum. LEWIS G. JACOBS, M.D.

Intussusception in Children: Spontaneous Reduction and the Sources of Error in Its Diagnosis. Hans Hellmer. Acta radiol. **25:** 514–526, Nov. 21, 1944. (In German.)

In children not all cases of intussusception are diagnosed roentgenologically. In some instances the intussusception is so small that it does not lead to symptoms before spontaneous cure. Even if symptoms are present, cases may not be studied because of early operation or death. In some instances the barium enema reduces the condition so rapidly that the disease is not observed by the roentgenoscopist. This is most often true of intussusceptions at the ileocecal valve. Other cases undergo spontaneous reduction before examination. In such instances the residual roentgen signs are not striking, consisting of an accentuated mucosal pattern, swelling of the ileocecal valve, or swelling (edema) of the ileal or cecal wall producing a filling defect. The importance of negative findings in the interval is that they indicate a better prognosis for non-recurrence.

Two illustrative cases are cited. In the first a chronic ileocecal intussusception, demonstrated roentgenologically, disappeared without treatment. In the second, the condition was reduced by the enema examination; the fluoroscopist, however, mistook barium in the sigmoid for terminal ileum and reached an erroneous diagnosis. LEWIS G. JACOBS, M.D.

On Strangulating Obstruction of the Small Bowel with Special Reference to Cases with Poor Roentgen Findings. J. Frimann-Dahl. Acta radiol. **25:** 480–492, Nov. 21, 1944. (In English.)

Among 228 cases of mechanical ileus, with the obstruction situated within the abdominal cavity, 32 cases of true strangulation occurred. Twelve of the 32 cases showed scant or nearly negative roentgen findings. In all 12 cases a strangulation ileus was found and in most instances resection had to be done. The reasons for the lack of roentgen evidence of strangulation in nearly one-third of the cases are discussed. The cause is presumed to be a special mechanism with regard to the accumulation of intestinal gas. On the basis of these observations, the author recognizes two types of strangulating obstructions as seen roentgenologically. One, with clear gas and fluid levels, gives positive findings; in the other, with a lack of intestinal gas, the picture is practically negative.

Technic of Contrast Examination of the Sigmoid Colon. Lars Billing. Acta radiol. **25:** 418–422, Nov. 21, 1944. (In German.)

The hazard of overlooking a lesion in the sigmoid on account of the overlapping of the loops can be avoided by pushing the sigmoid above the ileopectineal line, which is accomplished by filling the bladder. Ingestion of large amounts of fluids several hours before examination is the method recommended. The rectosigmoid junction is best studied by a film made with the central ray directed into the pelvic inlet, either by tilting the tube 35° or by raising the back from the table a corresponding amount. [While these two procedures appear to have a limited sphere of usefulness, the commonly employed technic of spot-film radiography under fluoroscopic control, especially in oblique projection, appears to have a greater useful field of application.—L. G. J.] LEWIS G. JACOBS, M.D.

Case of Fluoroscopically Reduced Sigmoid Volvulus. Bengt S. Holmgren. Acta radiol. **25:** 564–568, 1944. (In German.)

The author reports two cases of sigmoid volvulus. His original technic of passing a gastric sound into the volvulus under fluoroscopic control failed in the first case, but successful reduction was obtained by passing a stomach tube into it under fluoroscopic control (with barium enema) and injecting fluid into the aboral segment of the sigmoid. LEWIS G. JACOBS, M.D.

Stenosis of the Sigmoid in the Newborn. W. R. Bagley and E. C. Bagley. Minnesota Med. **28:** 455–457, June 1945.

After a rather general discussion of congenital atresia or stenosis of the bowel in the newborn, with statistics of its incidence in various parts of the intestinal tract, the author reports his own case, in which the stricture involved the first part of the sigmoid. Signs of obstruction appeared about forty-eight hours after birth, when the abdomen became distended and the infant began to vomit green-colored mucus. The diagnosis was made roentgenologically with the aid of a barium enema, the obstruction being localized in the sigmoid where it crosses the pelvic brim. Above this point the intestinal loops were greatly distended with gas. The stenosed loop of bowel was exteriorized at operation and a catheter placed below the bowel to secure the loop outside. Another catheter was placed in the bowel for decompression, the usual double-barreled colostomy being subsequently made. Three months later the continuity of the bowel was restored, and at eight months the child appeared entirely normal. The surgical problems arising in the handling of the tiny colon of an infant are described as they were successfully solved in this case.

PERCY J. DELANO, M.D.

Cases of Intermittent Colon Invagination on the Basis of Tumor. Gösta Lindquist. Acta radiol. **25:** 641–648, Nov. 21, 1944. (In German.)

This report describes two cases. The first was a colocolic intussusception on the basis of a carcinoma of the sigmoid; the act of invagination was observed fluoroscopically. When invagination occurred, the patient experienced a sensation of blocking of the colon. In the second case a polyp of the sigmoid offered some diagnostic difficulty; eventually the diagnosis was made and the polyp removed.

LEWIS G. JACOBS, M.D.

Unusual Case of Pure Colon Invagination. Arne Clausen. Acta radiol. **25:** 423–426, Nov. 21, 1944. (In German.)

The author reports a case of colocolic intussusception occurring in the sigmoid, apparently due to a band of adhesions. The patient recovered following operative reduction.

LEWIS G. JACOBS, M.D.

Megacolon in the Newborn. A Clinical and Roentgenological Study with Special Regard to the Pathogenesis (A Preliminary Report). Th. Ehrenpreis. Acta paediat. **32:** 358–370, 1945. (In English.)

A clinical and roentgen study of the onset and course of megacolon in 9 newborn infants showed the underlying factor in this condition to be a disturbance in the emptying of the bowel. Roentgenographically megacolon, as a development secondary to such disturbance, is shown to occur within a varying period of time, which was established in 4 of the present series as from three weeks to three and a half months. One patient with intermittent symptoms had a normal colon picture at the age of one month; at three and a half months there was only a moderate dilatation of the sigmoid; and at the age of ten months, a colossal dilatation of the whole colon. Redundancy of the colon and of the sigmoid, in particular, was not more marked than in normal infants. No localized obstruction was detected.

This study does not support the malformation and obstruction theories for megacolon.

(*a*) Cases previously described as megacolon in the newborn and in infants are of too long standing to prove the congenital nature of the changes, or too uncertain to establish their megacolon nature. The abdominal distention soon after birth in infants with megacolon is a manifestation of a disease resembling ileus and does not prove the congenital dilatation of the colon.

(*b*) The significance attributed to colonic redundancy is based on insufficient knowledge of the normal anatomy of the colon in the newborn. The redundant colon at this stage is, no doubt, due chiefly to the fact that the space left to the colon is considerably reduced by the largeness of the liver and the smallness of the pelvis. The colon therefore takes a sinuous course, which must be considered as physiological with regard to this particular age.

Megacolon may thus be characterized as a dilatation and hypertrophy of the colon owing to disturbed evacuation of the bowels. The particular kind of disturbance and the possible existence of a neuro-anatomical substratum have not as yet been elucidated. For the time being, therefore, it is consistent with prevailing terminology to define this disturbance as a functional disorder.

Luetic Rectal Stricture. A. Melamed and S. M. Feld. Am. J. Digest. Dis. **12:** 203–206 June 1945.

A case of syphilitic stricture of the rectum is reported by the authors, who believe it to be a rare condition. The patient, a white female aged 36, complained of diarrhea and postprandial colicky pains starting in the epigastrium and radiating to the lower abdomen. There was no history of nausea, vomiting, or melena. A barium enema revealed a smooth constriction of the rectum, measuring 4 inches in length. There was no evidence of ulceration. Blood Kahn tests were repeatedly positive (4+). Frei tests taken on two occasions were negative. Antisyphilitic therapy was given over a period of two years, during which time the area was checked by successive x-ray examinations. The plates shown with this article demonstrate a gradual decrease of the amount and extent of the stricture.

There are many causes of constriction of the rectum, the most common being gonorrheal proctitis. If this is suspected, a search for the Gram-negative diplococcus should be made. Lymphogranuloma inguinale will show a positive Frei test and will not improve under antisyphilitic treatment. It will also show evidence of mucosal destruction, sinuses, and fistulous tracts. Carcinoma usually occurs on the anterior wall of the rectum and a biopsy will give a positive diagnosis. Diverticulitis usually occurs at the junction of the descending and sigmoid colon; if there is an associated carcinoma in the same area, diagnosis may be difficult. The lesions of endometriosis are shown as sharply demarcated areas on x-ray examination.

JOSEPH T. DANZER, M.D.

Calcified Appendices Epiploicae as Freely Mobile Bodies in the Abdominal Cavity (A Roentgendiagnostically Interesting Subsidiary Find). Olallo Morales. Acta radiol. **25:** 653–661, Nov. 21, 1944. (In English.)

A case of a freely mobile calcification, situated within the abdominal cavity, diagnosed roentgenologically and proved histologically to be a calcified appendix

epiploica, is presented. Six similar hitherto unverified cases were collected by the author from the records of the Roentgen Department of the Karolinska Institute; five of these showed calcifications with considerable mobility, while the sixth showed a calcification which could not be displaced but which lay outside the adjacent organs. The author considers it probable that the calcifications in these cases originated from appendices epiploicae detached from, or still adhering to, the colon.

THE LESSER PERITONEAL SAC

Radiological Findings in Lesser Sac Effusions. M. C. Morrison. Canad. M. A. J. **52:** 474–477, May 1945.

Two unusual cases characterized by collections of fluid in the lesser peritoneal sac are reported. The first patient was a two-year-old girl who experienced a sudden attack of severe abdominal pain. The abdomen was distended, tense, and rigid, with no palpable mass. The white cell count was 22,500. Surgical exploration was considered inadvisable. Eight hours after onset, swelling and crackling of the soft tissues of the neck and upper chest were noted. Aspiration of the stomach contents produced only 15 c.c. of colorless fluid microscopically negative for blood. The temperature ranged between 99 and 100° F., and the pulse was fast and irregular.

X-ray examination of the abdomen, limited to the anteroposterior view with the patient in the supine position, revealed a circular area of finely stippled increased density in the left upper quadrant with downward displacement of the splenic flexure of the colon to the level of the iliac crest. There was a small pocket of air in the lower mediastinum and a triangular opacity in the region of the left leaf of the diaphragm, but the lung fields were otherwise clear and the heart normal. The spleen was not visualized but the left kidney was clearly outlined. The stomach air bubble was absent. The tentative diagnosis was volvulus of the stomach with collections of fluid and air in the lesser peritoneal sac or partial herniation of the stomach through the diaphragm. Radiographs made six hours later showed a decrease in the size of the cystic area with air extending from the mediastinum into the soft tissues of the neck, and at this time a rupture of an abdominal viscus was suggested.

Death occurred twenty-two hours after onset of the illness. Necropsy was done and the final diagnosis was strangulation and perforation of the stomach with extravasation of gastric content into the lesser peritoneal sac followed by pneumoperitoneum and mediastinal emphysema.

The second patient was a female 58 years of age who was operated on for chronic cholecystitis with cholelithiasis. The immediate postoperative course was uneventful, but after the patient's discharge colicky pain recurred, and two months later she suffered a severe chill with pain in the left shoulder and epigastric distress. There was dullness over the lower part of the left side of the chest, and aspiration in the ninth interspace posteriorly resulted in the removal of one liter of fluid resembling a thick bile. On readmission to the hospital, the patient appeared toxic, with rapid pulse but normal temperature and no dehydration or jaundice. The abdomen was tense, with a tender area of dullness in the hypochondrium, extending down to the umbilicus. The white cell count was 17,500. Stool and urine were negative for bile. The clinical impression was extravasation of bile into the lesser peritoneal sac, so confined by closure of the foramen of Winslow. Radiographic studies confirmed this impression and revealed a homogeneous opacity of fluid density in the lower part of the left lung field, elevation of the left leaf of the diaphragm, and a mass of increased density in the pancreatic area confluent with the liver shadow. The kidney outlines were apparently normal. The stomach, as outlined by barium, showed the upper border displaced downward and backward about 3 or 4 inches, apparently by extrinsic pressure. At operation, about 1 liter of brownish-yellow fluid was drained from the lesser peritoneal sac. There was no fluid in the greater peritoneal sac. The pathological diagnosis was hepatic degeneration, cholangiitis, and bile peritonitis of the lesser sac. The patient had an uneventful recovery. X-ray examination three weeks later showed a marked reduction in the size of the mass indenting the stomach outline. The source of the bile in this case was probably leakage around the drainage tube in the cystic duct. The tension of the effusion was attributed to three factors; the ball-valve action at the foramen of Winslow, the exudation of serum from the cells of the sac due to irritation by the bile salts, and the bellows action of the diaphragm.

On the basis of these cases the author lists the roentgen signs of effusion in the lesser peritoneal sac. They are: (1) a direct shadow on the roentgenogram if the collection of fluid is large; (2) expansion of a pancreatic area causing a pressure deformity on the air- or barium-filled stomach, probably on the lesser curvature and posterior wall, in small effusions; (3) displacement of the stomach downward, to the left and posteriorly, in large effusions, evident on lateral and anteroposterior films; (4) preservation of the kidney outline; (5) increased pliability and compressibility of the gastric walls on fluoroscopic palpation; (6) chest findings similar to those in other subdiaphragmatic lesions—elevation of the diaphragm, chiefly the left leaf, with decreased respiratory movement and decreased radiability of the lower lung fields, possibly with a "strand shadow," probably from pleural transudate.

In the differential diagnosis, one must consider pseudocyst of the pancreas, true cyst of the pancreas, primary cyst of the omentum, subdiaphragmatic abscess, and retroperitoneal tumors. Cysts of the head of the pancreas enlarge the duodenal loop but cysts of the body and tail of the pancreas may simulate the described condition very closely. Primary cysts of the omentum are usually localized and movable. Subdiaphragmatic abscess is much more common on the right side. It often contains air and is usually associated with fever. BERNARD S. KALAYJIAN, M.D.

THE SMALL PELVIS

On the Roentgen Diagnosis of Space-Restricting Processes in the Small Pelvis. Lennart Walldén. Acta radiol. **25:** 856–873, Nov. 21, 1944. (In English.)

Cystography has been found of great assistance by the author in the diagnosis of space-restricting processes in the small pelvis which do not appear at all, or less distinctly, on an ordinary roentgenogram. It is especially useful in cases where exploration or palpation is difficult or impossible.

The technic as developed in the investigation of 40 such cases is described and illustrated by numerous roentgenograms. After voiding, the bladder is filled

with 200–250 c.c. of air, eventually supplemented by a rather small amount of contrast fluid. (Astrabaryt in a potassium permanganate solution was found to give the best results and is easily removed by rinsing the bladder.) Pictures are then taken in rapid succession in order to avoid the refilling of the bladder with urine. With the patient supine, frontal and lateral views are obtained, and following these, "pictures with vertical rays with the patient turned slightly to the right and left." Additional views may include a film with vertical rays with the patient in a half-sitting position and films with horizontal rays with the patient lying on his right and left sides. Films may also be taken with the intestines filled with a contrast medium.

The location, form, expansion, and displaceability of space-restricting processes in the small pelvis can be determined in relation to the distended bladder and the adjacent contrast-filled intestines. In certain cases the topographical character of the formation, when taken in conjunction with the clinical data, offers the possibility of determining the approximate nature of the process.

THE MUSCULOSKELETAL SYSTEM

The Intervertebral Disc: Its Microscopic Anatomy and Pathology. Part I. Anatomy, Development, and Physiology. Part II. Changes in the Intervertebral Disc Concomitant with Age. Part III. Pathological Changes in the Intervertebral Disc. M. B. Coventry, R. K. Ghormley, and J. W. Kernohan. J. Bone & Joint Surg. **27:** 105–112, 233–247, 460–474, January, April, July 1945.

This excellent series of articles considers the changes that take place in the intervertebral disk at the lumbosacral level, reporting the findings in a series of 88 cases, including both the roentgenologic and the pathologic features. The lumbosacral area was chosen because that region is the most frequent site of clinical complaints and because many congenital changes are found there.

The material for this study was obtained from routine necropsies. The disks with the body above and part of the sacrum were removed, fixed in formalin, x-rayed, decalcified, and stained. The sections were studied microscopically and by projecting the sections containing the whole disk on a screen.

The vertebral body is composed of cancellous bone with dense smooth bone plates on the superior and inferior surfaces. These plates are divided into three zones; the central, with numerous small holes; the peripheral, with larger and less numerous holes; and the epiphyseal ring, surrounding the outside of the plate. The disk is composed of a cartilaginous plate, covering the bone plate of the vertebra; the annulus fibrosus arising from the cartilaginous plate and surrounding the nucleus pulposus; and the nucleus pulposus, which is a semigelatinous material.

The vascular channels in the cartilaginous plates are present only in the first three decades of life. The epiphysis is found to be a complete bony ring about the vertebral body and is not absent posteriorly. The disk does not have a joint cavity.

In the second paper of the series the macroscopic and microscopic changes are minutely considered according to decades. The various components are described separately for each decade, with demonstration of degenerative changes in the latter part.

The third paper discusses the various pathologic changes. Hypertrophic arthritis is evident by the presence of osteophyte formation and is assumed to be due to bone formation along the Sharpey fibers that have been subjected to strain from the longitudinal ligaments.

Nuclear expansion begins after the fifteenth year. This is usually a normal variation but in extreme degree is considered pathological. Usually the cartilaginous plate is thin and defects may be present. The expansion is probably due to a high water content of the nucleus.

Ballooned disks are always found in the presence of decalcification of the vertebrae. The disks are in good condition, but there is a definite decrease in the number and width of the trabeculae of the bodies.

Where the disk is thinned, this is found to be due to (*a*) desiccation and necrosis of the nucleus or (*b*) rupture of the annulus or defective cartilaginous plate or both.

Intraspongy nuclear herniation occurs through a defect in the cartilaginous plate and is not evident on a roentgenogram until sclerosis of the surrounding bone occurs. The herniation probably does not cause pain, but symptoms may occur as the result of the hernia, with thinning of the disk, degenerative changes, and shifting of the axis of motion.

Anterior nuclear protrusions are rare but an example was found in this series. There is a break in the anterior longitudinal ligament. The hernia is composed of desiccated nuclear material with degeneration of the disk.

Posterior nuclear protrusion is quite common. It is the result of trauma, with rupture of the posterior longitudinal ligament and the posterior portion of the annulus and a loss of nuclear substance, followed by thinning of the disk.

The entire disk may become calcified or any portion may contain calcium deposits. Such calcification is easily recognized.

Invading infection of the disk is usually secondary, arising from adjacent vertebrae or along the ligaments or by way of the blood stream. In tuberculosis the disk may become involved early by spread along the longitudinal ligaments. In brucellosis the infection invades the disk before the vertebrae.

Malignant invasion of the disk rarely occurs. One specimen showed metastatic carcinoma of the vertebra with protrusion of the disk into the body but no disk destruction or invasion. JOHN B. MCANENY, M.D.

Rôle of the X-Ray in the Diagnosis of Posterior Herniation of the Intervertebral Disc. Arthur E. Childe. Canad. M. A. J. **52:** 458–470, May 1945.

The author gives an excellent survey of the history of myelography by different methods, showing the advantages and disadvantages of each. He prefers the use of pantopaque and believes that it is necessary to inject 5 to 6 c.c. if one is to find many of the smaller disk lesions which may easily be missed with smaller amounts. He gives a detailed description of the technic for injection of the material, only a few points of which can be mentioned here. After successful spinal puncture has been accomplished, a small amount (0.25 c.c.) of pantopaque should be injected and the patient observed fluoroscopically to be sure that the material is going into the subarachnoid space. If this droplet of oil is seen to move freely as the table is tilted, one can go

ahead with the injection of the remaining portion. It has been found that, even though spinal fluid drops freely from the needle, one may inject oil into the subdural rather than the subarachnoid space. After the injection has been completed, the needle is left *in situ* for later aspiration of the oil and is covered with sterile gauze strapped down to the patient. Careful fluoroscopic study of the oil and its movement up and down the spinal canal with tilting of the table is carried out. The patient is first studied in the prone position and later turned 35 to 40 degrees to one side and studied in the oblique position. The opposite oblique is also studied. The author does not feel that the lateral position is very helpful. Adequate spot films should be made throughout the examination to record the changes seen fluoroscopically.

After completing this part of the examination, the patient is returned to the prone position and the oil is pooled under the point of the needle by tilting the table under fluoroscopic guidance. The author goes into considerable detail regarding the aspiration of the oil and gives several helpful hints. He feels that with patience, careful manipulation of the patient, and a certain amount of ingenuity and experience, one should be able to aspirate almost all of the oil in the drainage sac. Since the original spinal puncture is usually made between L3 and L4 to avoid the most common sites for nucleus lesions lower down, it is sometimes practical to make a new spinal puncture at these lower levels for aspiration of the oil, if it cannot be withdrawn through the original puncture.

In examining the cervical portion of the spine, the author suggests the use of soleless leather boots laced about the patient's feet and ankles and attached to the end of the table by straps. With these in place, the patient is more easily handled and one can tilt the head downward almost to the vertical position if necessary. It is unnecessary to keep the oil in one mass as it passes over the thoracic hump, as it tends to agglomerate when it reaches the cervical region. Extension of the neck will prevent the oil from passing upward into the head.

The author believes that plain radiographic studies should be made on each case. He does not believe that these are very often diagnostic of nuclear herniation but may be suggestive. This is particularly true with narrowing of the disk space between L4 and L5 and localized hypertrophic bony changes. Mention is also made of unilateral sacralization of the transverse processes of the fifth lumbar as frequently associated with herniation of the disk between L4 and L5.

The illustrations in this article show the classical defects seen with the larger herniated nuclei and also some of the smaller changes which have been found by the author at operation to be due to disk herniations. He believes it is important to study very carefully the axillary pouches as outlined by the oil and to watch the column of oil as it passes up and down over the suspected area. Minute asymmetries of the axillary pouches or minute changes in the speed of passage of the oil over one side as compared with the other may indicate the presence of a nuclear herniation which would be missed in a less careful examination.

Multiple herniations are not uncommon. Usually only one of these produces symptoms. If myelography is not done preoperatively, only one area may be explored and the operation will be a comparative failure, since the other nuclei may later cause trouble. A warning is issued against attempting myelography within a few days after a spinal puncture for diagnostic purposes, since many curious defects may be shown, which are misleading and result in erroneous conclusions, as proved by later studies.

Herniations of the intervertebral disks of the upper lumbar and thoracic vertebrae are far less common than those of the lower lumbar region. The author believes, however, that disk herniations are fairly common in the lower cervical region. The plain films of the cervical spine, particularly oblique views, may be very suggestive of the presence of herniated disk. Because of the width of the spinal canal at this level, it is very important that 5 to 6 c.c. of opaque oil be used. With smaller amounts, the layer of oil will be so thin that the appearance is somewhat deceiving. The technic for study of this region is very similar to that used in studying the lower parts of the spine. On completion of the examination, the oil is returned to the lower part of the spine for aspiration.

It has been found that weight-bearing may increase considerably the size of a given defect in the myelogram. The application of traction on the feet and shoulders may reduce the size of the defect. In a nervous, tense individual, the defect may appear larger than it does later when the patient becomes more relaxed. Flexion of the spine tends to decrease the size of the lesion and extension to increase it.

As to the differential diagnosis, hypertrophy of the ligamentum flavum produces a defect in the posterolateral portion of the subarachnoid space, whereas the herniated nucleus is in the anterolateral portion. A very swollen nerve root may produce a defect simulating that of a disk herniation. Tumors of the cord usually produce more sharply outlined defects or a complete block, and extradural tumors usually produce a block which is not opposite the intervertebral space.

BERNARD S. KALAYJIAN, M.D.

Instability Associated with Disk Degeneration in the Lumbar Spine. Folke Knutsson. Acta radiol. **25:** 593-609, Nov. 21, 1944. (In English.)

In an attempt to produce a functional test of the stability of the disk junction, profile roentgen pictures of the lumbar spine were taken in a series of 140 cases with the patient in the upright position and bending as far backward and as far forward as possible. In normal cases parallel displacement does not take place between the vertebral bodies, and the tilting between the vertebrae is harmonious and similar throughout. When the disk is degenerated, there often appear signs of instability in the form of parallel displacement and abnormal tilting movements. In a large number of cases these signs of instability were the only manifestation of disk degeneration, the intervertebral space and surfaces of the vertebral bodies being intact. Thus, the author's method often permits early diagnosis. In 71 of the 140 cases examined, the findings were negative, signifying that the vertebrae and intervertebral spaces were free of changes and that there was no instability. In 16 of the 69 cases with disk degeneration, two disks were affected and in 1 case three disks. Only one disk was involved in the remaining cases. The total number of degenerated disks was thus 87. In 58 of the number there were anatomic signs of degeneration. Eighteen of the disks were anatomically normal but showed instability. Spondylolisthesis was present in 11 patients.

Occurrence and Significance of Early Periosteal Proliferation in the Diaphyses of Premature Infants. Nils Malmberg. Acta paediat. **32:** 626–633, 1945. (In English.)

This paper deals with 114 premature infants, 72 of whom had received prophylactic antirachitic therapy in the first week of life. Forty-two infants receiving no such treatment served as controls. The infants were cared for in a special ward and were reared for the most part on human milk, supplemented with small additions of Czerny's flour and butter gruel during the early part of the investigation and later with citric acid milk.

Roentgenograms were taken at varying intervals over a twelve-month period of the costochondral junctions, the bones of the forearm and leg, and in some cases the bones of the upper arm and thigh. The films revealed in a great many of the infants, both treated and untreated, a linear periosteal deposit of calcium of varying length along the diaphysis, usually on the tibia, but in some infants on the fibula, radius, femur, and humerus. It was generally observed at four to six weeks of age; in a few instances as early as three weeks, in a few not until eight to ten weeks, and in a few at twelve weeks. In some instances it was merely a fine, almost indistinguishable, line; in others it was somewhat thicker. In later films it was possible in some individuals to distinguish deposits arranged in layers. Within two to four weeks the deposit in its less severe form had in some instances fused with the bone and become wholly or almost indistinguishable. In cases where the deposit was thicker or in layers, it was visible for a long period of time in the form of a thickening of the corticalis. Sometimes the calcareous deposit was separated from the original cortex by a narrow rarefied zone resembling an extra marrow space. Films taken two to four weeks before the appearance of the calcium deposits in many of these cases showed that the corticalis was unclear and indistinctly outlined against the soft tissues at the site of the deposit which was later to appear; the surface seemed to be slightly fluffy and not sharply outlined, indicating that periosteal proliferation of what was probably osteoid tissue, which was later to become calcified, was in progress.

Twenty-seven of the 42 control infants showed early signs of periosteal reaction in the various bones; in 15 of these, rachitic changes appeared later. Ten of 29 infants receiving 2,700 international units of D_3 from and including the fourth to the sixth day of life, 14 of 29 infants receiving 10,000 international units from and including the fourth to the seventh day of life, and 3 of 14 infants receiving 500,000 international units of vitamin D_2 in two doses, on the fourth and seventh days of life, showed periosteal proliferation in the diaphyses. Only 6 of the treated cases later showed signs of rickets.

The author concludes that periosteal proliferation at the diaphysis of the long bones, especially of the tibia, is a sign of vitamin D deficiency and should be regarded as the earliest roentgen evidence of rickets, often appearing four to six weeks before the epiphyseal change.

Etiology of Osteochondrosis Dissecans. S. Ribbing. Acta radiol. **25:** 732–755, Nov. 21, 1944. (In German.)

On the basis of statistical and pathological studies, the author advances the theory that osteochondritis dissecans results from detachment of a superficial accessory nucleus of bone (found in the femur in childhood), which is considered to remain relatively isolated from surrounding bone because of persisting bands of epiphyseal cartilage, and therefore to be unusually prone to loss of circulation from minor traumata, even those due to normal function. This explains the fact that the articular cartilage as such remains intact. LEWIS G. JACOBS, M.D.

Albright's Syndrome (Polyostotic Fibrous Dysplasia with Cutaneous Pigmentation in Both Sexes and Gonadal Dysfunction in Females). Malcolm B. Dockerty, Ralph K. Ghormley, Roger L. J. Kennedy, and David G. Pugh. Arch. Int. Med. **75:** 357–375, June 1945.

Six new cases of Albright's syndrome, encountered at the Mayo Clinic, are reported, bringing the total number of cases recorded in the literature to 39. Roentgenograms from one case are reproduced. A comprehensive discussion of the roentgenologic characteristics and pathological features of this condition is included. Two of the authors' observations are contrary to the general impression obtained from the literature. One is that extraskeletal manifestations may occur in the absence of extensive osseous lesions; the other that clinically silent but roentgenologically extensive and active lesions of bone can be present in adults who have Albright's disease.

Bone Sarcoma in Polyostotic Fibrous Dysplasia. Bradley L. Coley and Fred W. Stewart. Ann. Surg. **121:** 872–881, June 1945.

The authors report two cases of bone sarcoma arising on the basis of fibrous dysplasia. In both instances the patients reported to the hospital because of pain and a tumor, and in both cases an identical histologic pattern, consisting of non-bone-forming pleomorphic spindle- and giant-cell sarcoma, was observed. Both tumors appeared radiographically to have produced metastases, while the relief of pain subsequent to small doses of radiation was remarkable.

ELLWOOD W. GODFREY, M.D.

Different Types of Osteo-Arthritis in the Hip Joint and Their Connection with the Anatomical Conditions. Does There Exist Any Subluxation Coxae Acquisita? Ivan Hermodsson. Acta radiol. **25:** 527–550, Nov. 21, 1944. (In English.)

Roentgen signs of osteoarthritis of the hip point to a definite connection with the anatomy of the joint.

The *CE* angle as described by Wiberg (Acta chir. Scandinav. Supp. 58, 1939) is used to distinguish between the normal joint and one not normally developed. *C* denotes the center of the femoral head, *E* the lateral edge of the acetabular roof. The sides of the *CE* angle are formed by the line between *C* and *E* and by a line drawn through *C* in the longitudinal axis of the body. *CE* angles below 20 degrees may be considered definitely pathologic and indicate a defective development of the acetabular roof, while values over 25 degrees are definitely normal. Values between 20 and 25 degrees are uncertain. Large *CE* angles are more common in males and small *CE* angles in females.

In a series of 170 joints showing signs of osteoarthritis the author found a definite connection between the localization of cartilage destruction and structural changes. With *CE* angles of less than 20 degrees, the destruction was localized solely or mainly in the upper part of the joint. With angles of 20 to 25 degrees the cartilage changes were also largely in the upper part, though the medial part was sometimes in-

volved. In the normally built hip joint (*CE* angle over 25 degrees), two types of osteoarthritis were distinguished. Type 1 shows destruction of cartilage mainly in the medial part of the joint, type 2 in the upper part. Osteoarthritis of type 2 has several interesting characteristics, above all a double floor. The author believes that osteoarthritis of type 1 is an expression of primary arthrosis deformans and type 2 a real chronic arthritis: So-called subluxatio coxae acquisita (Morville: Acta orthop. Scandinav. **4:** 133, 1933; **7:** 107, 1936) is only an example of osteoarthritis of type 2.

Subcostal Swelling of the Soft Tissues in Osteochondritis. Knut Lindblom. Acta radiol. **25:** 610–613, Nov. 21, 1944. (In English.)

Roentgenography has been found by the author to be of aid in the diagnosis of osteochondritis of the anterior ends of the ribs. With one exception, in 20 cases of osteochondritis tangential films showed a local swelling of the soft tissues on the inner side of the cartilage or at the junction between the cartilage and the bone. The swelling varied in thickness in different patients from 2 mm. to 2.5 cm. In most instances, it was situated at the level of the second rib; in the other cases it was seen in the region between the third and sixth ribs. Calcium deposits were present in two instances; but it was difficult to distinguish these from the normal calcifications of cartilage.

In the one case in which the roentgenogram was negative and operation revealed chondritis, there was a fistula leading to the sternal insertion of the second rib, and the absence of pathologic changes in the film was ascribed to the fact that the abscess must have drained through the fistula. In this patient, contrast filling along the fistula gave a local diagnosis.

Tangential films of the cartilage in 16 anatomic specimens from normal patients showed no swelling of the soft tissues such as was observed in the patients with osteochondritis.

Case of Chondrodystrophia Congenita Calcificans. Sigvard Jorup. Acta radiol. **25:** 580–586, Nov. 21, 1944. (In German.)

The author reports the case of a child with chondrodystrophia congenita calcificans, under observation from shortly after birth to the age of fourteen months. The condition is characterized by small, sharply defined areas of calcification in the bones preformed in cartilage, giving a characteristic picture. The bones may be small, and deformities are usually asymmetrical. The condition is probably related to classical chondrodystrophy; its occurrence is about 1 in 500,000 births. While prognosis is for progressive deformity, cases have not been followed for more than two years. A table of reported cases is included.

LEWIS G. JACOBS, M.D.

Case of Hurler's Disease (Lipochondrodystrophy). H. R. Sear and J. K. Maddox. M. J. Australia **1:** 488–492, May 12, 1945.

The authors are here dealing with a clinical entity which is as yet fairly new to the literature. It exists in several forms, all variants of one parent condition. This condition is as yet not too perfectly understood, with the result that many confusing classifications are appearing, some in textbooks which are considered authoritative and, indeed, are so in many respects.

The authors quote from "A Textbook of Radiology" by British authors: "Gargoylism appears to be an allied disease, in that bone changes identical with chondro-osteo-dystrophy are encountered. It was first described by Hurler, and is referred to as chondro-osteo-dystrophy of the Hurler type, but the name 'gargoylism', which is more commonly used, well describes the large head and grotesque facies of the children affected." From this they "beg to differ," taking the firm position that the disease is a lipochondrodystrophy.

It would not seem proper to let this statement go unchallenged. A thorough review of the literature—and the description by Brailsford (not cited by the present writers) is the first to follow the original description by Gertrud Hurler, though it was written ten years later (Am. J. Surg. **7:** 404, September 1929)—reveals no particular stress on the lipoid element in the dystrophy. As Brailsford approaches the subject, it represents a dystrophy in the transformation of cartilage into bone; splenomegaly and hepatomegaly may or may not be present; corneal opacities may or may not occur.

The authors present a case history. The condition they are doubtless describing is the one described by Gertrud Hurler in 1919, and by Brailsford in 1929. Morquio also described the condition in 1929, and his name has come to be attached to one type of the bone disease. All of the synonyms refer to one basic entity: it is known as Hurler's syndrome, osteochondrodystrophy, Morquio's disease, gargoylism, lipochondrodystrophy, and dysostosis multiplex. In 1941 Dr. Maximilian Hubeny and the abstracter made a rather complete study of a case, our report being one of the early ones in the American literature (Am. J. Roentgenol. **46:** 336, September 1941). At that time we had to orient ourselves, from a rather confusing and poorly co-ordinated group of case reports, in the matter of terminology. Going back to the basic articles, reviewing the reported cases and examining their roentgenograms, we chose the term dysostosis multiplex, which seemed then coming into favor, but later regretted that we did not cling to the name "Hurler's syndrome," since credit is due to Gertrud Hurler for the first comprehensive description of this entity.

Attempts to use the above-mentioned synonyms to designate separate disease entities is a step backward rather than forward and tends to create confusion. Even Caffey in his excellent textbook on Pediatric X-Ray Diagnosis has been ensnared by the confused terminology, and separates different types of one entity into distinct entities.

There is one cardinal diagnostic point which should be sought in dealing with any of the various types of Hurler's syndrome. The lateral view of the lumbar spine will usually exhibit—and rather early, too—a characteristic *beak-like deformity:* the lower anterior margin of the vertebral body projects forward; this, for the reason that ossification in the upper portion of the vertebral body is deficient. The appearance is so striking that, once seen, it will never be forgotten and never be confused with any other vertebral deformity. It is usually apparent at the first examination; if it is not found, or only suggested, a few more examinations at short intervals will usually suffice to demonstrate it most convincingly. Credit for stressing the characteristic vertebral deformity goes to Brailsford of England.

PERCY J. DELANO, M.D.

Identical Twins: Achondroplastic Dwarfs. S. J. Goodman. Ohio State M. J. **41:** 521, June 1945.

The author records briefly the delivery of twin achondroplastic dwarfs, who died shortly after birth. The mother was apparently in good health and roentgen studies showed no abnormalities of her pelvis or long bones. Two previous pregnancies had been normal. There was no history of any unusual illnesses in the family of either father or mother. Roentgenograms of the infants are reproduced.

GYNECOLOGY AND OBSTETRICS

Value of Hysterosalpingography in Diagnosis of Gynecological Affections. Origene Dufresne. Urol. & Cutan. Rev. **49:** 345–350, June 1945.

The author describes his technic for hysterosalpingography with lipiodol. The patient is given tincture of belladonna, 20 drops, one hour before the examination. The genitalia are prepared and the oil (usually about 5 c.c.) is injected with moderate pressure. Its progress is observed fluoroscopically, and films are taken as desired (65 kv., 80 ma., 1–2 seconds, with Lysholm grid).

Such examination supplements other methods of gynecological study and furnishes valuable information, often preventing unnecessary surgical procedures. It is indicated in metrorrhagia, sterility, genital pain, developmental anomalies of the internal genitalia, pelvic tumors, ectopic pregnancy, and for postoperative observation following surgery of the tubes. It is contraindicated in the presence of acute infection, profuse bleeding, and possible pregnancy, and immediately following a menstrual period.

The author outlines the findings in the normal genital tract and in various pathological conditions.

MAURICE D. SACHS, M.D.

Radiology of Pelvic Types and Their Obstetrical Significance. D. G. Maitland. M. J. Australia **1:** 537–539, May 26, 1945.

It is noteworthy that in the opening section of this paper the author admits that he has not felt adequate confidence in the Ball method of pelvicephalometry, inasmuch as "a volumetric method based entirely on the volume capacity of two pelvic diameters—namely, the conjugate diameter and the biischial diameter—would lead to errors in judgment of the true pelvic capacity, if the important factor of pelvic type was not considered at the same time." Thus, cesarean section might be done in a patient with a narrow biischial diameter, though the pelvis was otherwise adequate.

With regard to pelvic types, the author follows the classification of Swenson and Molloy: gynecoid, android, platypelloid, and anthropoid. He points out that pelvic shape is important from the standpoint of deep transverse arrest and deep posterior arrest of the fetal head. Transverse arrest is associated with the flattened posterior segment of the gynecoid, platypelloid, and android types; the arrested posterior position is associated with the anthropoid type.

In the flat type of pelvis, critical attention must be paid to possible cephalopelvic disproportion. In the android pelvis, there is an interference with anterior rotation: deep transverse arrest and a persistent posterior position are therefore to be kept in mind. The anthropoid pelvis may not be too formidable if there is no outlet contracture.

PERCY J. DELANO, M.D.

Pelvic X-Ray Measurements and Pelvic Contraction Eric W. Frecker. M. J. Australia **1:** 532–537, May 26, 1945.

In the beginning, the essayist stresses certain "postulates," which, he points out, apply not only to the roentgenology of obstetrics, but to the field of roentgenology as a whole: first, that adequate cognizance should be taken of the clinical findings and the clinical picture; second, that there is no such thing as an "x-ray diagnosis," but the diagnosis is to be arrived at by a careful consideration of all the ascertainable facts concerning a patient; third, that we are dependent, as radiologists, upon the clinician, and should obtain from him not only facts pertaining to the patient's particular problem, but also pertaining to the specialty he represents, the better to fortify our interpretations of shadows seen in films; fourth, that clinical knowledge in any field is necessary to prepare us for new radiologic advances, as in radiologic obstetrics and radiologic neurology; fifth, that we must strive to acquaint the various specialties with the possibilities and limitations of the roentgen ray in diagnostic work, that they may consult us for such aid as we are able to render, and not expect of us that which we cannot perform.

The essayist employs the pelvic type classification of Swenson and Molloy: gynecoid, android, anthropoid, and platypelloid. For pelvic mensuration, the Thoms method is preferred; though for pelvic cavity and outlet measurements, the Ball method is employed. A film is taken routinely in Chassard and Lapine's position (patient leaning forward while seated over the cassette, so that the pubic arch lies parallel and close to the film). The type of pubic arch is viewed with regard to its relation to a possible outlet contracture.

The Ball method for the pelvic interior has been found better than the "stereoscopic pointer" method. Both the Ball and Thoms methods have been found accurate, in inlet measurements, within 0.5 cm.

PERCY J. DELANO, M.D.

THE GENITO-URINARY TRACT

Roentgen Examination of the Urinary Tract with Special Reference to Methods of Examination and Findings in Individuals with Testicular Tumors. Joseph C. Bell, Gilbert W. Heublein, and Howard J. Hammer. Am. J. Roentgenol. **53:** 527–562, June 1945.

The technical aspects of the roentgen examination of the urinary tract are discussed and the roentgen signs in some of the diseases affecting it, especially testicular tumors, are described.

For intravenous urography, the proper selection of patients is important. Sensitivity to the contrast medium should be determined. Patients are prepared with castor oil or compound licorice powder given the evening prior to the examination. Food and fluid are withheld after midnight, and a cleansing enema is given one hour before the examination. The roentgen examination begins routinely, with a preliminary roentgenogram of the entire urinary tract; another film is made five minutes after the injection is completed and is developed immediately. Pressure is then applied over the sacral promontory by a compression band and balloon and maintained for five minutes, following which stereoscopic roentgenograms are made of the upper part of the tract. Pressure is then released, and an exposure of the entire tract is made immediately. If normal excretion is occurring on both sides, a roent-

genogram is made in the upright position, completing the examination. If there is delayed excretion, further studies may be done up to two and a half hours following the injection.

In retrograde urography the value of injection of the contrast material under roentgenoscopic guidance is stressed. Spot films can be obtained as indicated during the injection. Stereoscopic films of the entire tract and occasionally lateral views complete the examination. The lateral view has been found especially valuable in the diagnosis of metastases about the renal pedicles from testicular tumors.

By means of illustrative case reports the roentgen findings in various conditions affecting the urinary tract are presented. Displacements of the kidneys and ureters by metastatic masses about the renal pedicles may be a valuable diagnostic sign of testicular neoplasms, since the primary tumor may be extremely small. The various deformities and displacements due to other neoplastic masses, perirenal infections, and posttraumatic lesions are described. The lateral view has been especially helpful in recognizing these, particularly when the deformity is minimal. The article is well illustrated with a total of 41 figures, mostly reproductions of roentgenograms, and constitutes a general survey of the uses and value of retrograde and intravenous pyelography. L. W. PAUL, M.D.

Injuries of the Urinary Tract: Roentgenological Considerations. Arthur P. Echternacht. Urol. & Cutan. Rev. **49:** 357–365, June 1945.

In urinary injuries the type of therapy is largely determined by roentgenographic examination. Rupture of the kidney is found in about 1 out of every 3,000 hospital admissions for injuries. The damage may consist in ecchymosis, subcapsular rupture, or total rupture. Hematuria is almost always present unless there is a block of the ureter. A scout film may reveal absence of the renal or psoas shadow, enlargement of the kidney shadow, fracture of adjacent skeletal structures, paralytic ileus, and compensatory scoliosis. None of these findings, however, is pathognomonic of renal injury. For a comprehensive diagnosis pyelographic studies are required. These will reveal "(1) complete or partial impairment of excretory function on the injured side; (2) failure of one or more calices to visualize due to injury of that portion of the kidney draining into those calices and/or blood clots; (3) distortion and compression of the calices and infundibula, producing a spider-like appearance due to edema and hemorrhage into the surrounding renal parenchyma; (4) irregular filling of the calices and/or pelvis due to blood clots; (5) extravasation of the opaque medium extending fan-like from a calix into the renal parenchyma; (6) evidence of extrarenal extravasation; and (7) distortion of pelvic shadow and evidence of extravasation from the pelvis." The author discusses the advantages and disadvantages of excretory and retrograde pyelography, favoring excretory studies in cases of renal injury.

Injuries of the ureter are rare. They occur most commonly in association with pelvic surgery. Excretory urography is the diagnostic method of choice. It will indicate which ureter has been injured and the level of the injury. If, however, a ureter has been ligated during a surgical procedure, ureteral catheterization and retrograde injection of one of the commercially prepared contrast media will be necessary to determine the point of obstruction and any associated ureteral displacement.

Bladder injuries are most commonly the result of external force upon a distended bladder. Rupture may be intraperitoneal or extraperitoneal. Pain and hematuria are constant findings. Here, too, excretory urography is superior to other methods. The chief roentgen evidence is extravasation of the opaque medium. Anteroposterior and lateral films should be taken as a routine because most bladder ruptures occur in the posterior wall.

Urethral injuries are uncommon. Urinary retention, pain, and shock are common findings. Careful examination should be sufficient in making the diagnosis. Excretory studies will help in ruling out injuries of the proximal urinary tract.

Not only are pyelographic studies of diagnostic value in injuries of the urinary tract, but they are of great importance in follow-up observations.

MAURICE D. SACHS, M.D.

Obstruction of the Ureter in Children. Charles J. E. Kickham. J. Urol. **53:** 776–780, June 1945.

The author stresses the need for a greater effort on the part of urologists to bring about a uropediatric consciousness among the medical profession. The best possibilities for preventive urology lie in the early diagnosis and prompt treatment of diseases and abnormalities of the urogenital system in early life, since a high percentage of urinary tract diseases have a congenital background. Kidneys are being sacrificed daily in adult and adolescent life because of irreversible destructive renal disease which had its origin as a urinary infection in a congenitally handicapped kidney in infancy or childhood.

The development and refinement of urological instruments and the introduction of excretory urography have facilitated the examination of the urinary tract in infancy and childhood. Intravenous urography has proved, also, to be an ideal method of measuring functional and anatomical restoration following conservative renal surgery.

The author discusses certain signs and symptoms which should direct the attention of the medical attendant to the possibility of serious urinary-tract disease in the young. The presence of persistent pus in the urine without response to medical treatment, symptoms of vesical irritation, especially so-called enuresis, which do not respond to a reasonable period of therapy, hematuria, enlargement of one or both kidneys, and abdominal pain of possible urinary tract origin are mentioned as indications for more complete urological study.

Ureteral obstruction leads to chronic infection with a resultant hydronephrotic destruction of the kidney. It may occur at any point, but is more common in the ureterovesical and ureteropelvic regions. It may at times be acquired, as a result of calculus, stricture, or an extraureteral lesion. Stricture at the junction of the ureter and bladder, aberrant vessels, and ureterocele are the more common abnormalities causing congenital obstruction in the ureterovesical region; stricture, high insertion of the ureter, and anomalous blood vessels in the ureteropelvic region. Such conditions must be recognized early, as delay in diagnosis and treatment will lead to irreparable renal damage.

To attain the necessary objectives of non-radical surgery for hydronephrosis, the symptoms must be relieved, the obstruction permanently removed, infection eliminated, and renal function conserved and restored. The postoperative evaluation of surgical results is extremely important. A successful result must be confirmed by urography after a reasonable postoperative period in order to avoid false impressions of cure.

Five basic operative technics are listed by the author for the surgical management of ureteropelvic obstruction. One case of congenital obstruction of the right ureteropelvic junction with high insertion of the ureter in a three-year-old child is mentioned, with clinical cure and follow-up confirmatory urographic study.

JOHN H. FREED, M.D.

TECHNIC

Military Photoroentgen Technique Employing Optimum Kilovolt (Peak) Principles. Arthur W. Fuchs. Am. J. Roentgenol. **53:** 587–596, June 1945.

The optimum kilovoltage theory of technic is based upon the premise that for every roentgenographic projection, there is an optimum kilovoltage that will fully penetrate a given part with the production of a minimum of secondary radiation fog. The extensive use of photoroentgen examination by the Armed Forces brought to light a number of faults in commonly used technics. These included use of too low kilovoltages, too high milliamperages, and inadequate development or failure to use time-temperature development. In order to eliminate the variable factors as much as possible, increase roentgen-ray tube life, and improve the diagnostic quality of the photoroentgenograms, the optimum kilovoltage technic was applied. The use of this technic depends upon the classification of all body parts into three groups, small, average and large, for the purpose of facilitating the use of time factors in convenient multiples, and upon a standardized processing procedure.

For photoroentgenography, a generator capable of delivering 100 kv.p. at 200 ma. should be employed. A synchronous timer capable of timing in tenths of seconds is necessary. The constant factors include a kilovoltage of 100, milliamperage of 150, distance of 36 inches, and use of a stationary grid. The time is varied according to the size of the patient, 0.2 sec. for small (17–24 cm. chest thickness), 0.3 sec. for average (25–27 cm.) and 0.3 sec. for large (27–32 cm.). For chest thicknesses above 32 cm., 14 × 17-inch films are used.

The use of such a high kilovoltage provides a long-scale contrast, so that all detail is visible, yet the density is never excessive; the abundant secondary radiation produced is controlled by the stationary grid. The long axis of the roentgen tube should be vertical, with the cathode end uppermost. In this position the greatest quantity of roentgen rays is directed toward the upper thorax, where the greatest tissue density usually exists. The rate of operation should be one stereoscopic pair per minute. In processing, a standardized time-temperature method is essential. Photoroentgen film requires eight minutes development at a temperature of 68° F. in fresh Kodalk developer. Lack of adequate development was a major factor in the poor results obtained earlier.

L. W. PAUL, M.D.

Wet-Film X-Ray Viewing Room. Leo H. Garland and Milo T. Harris. U. S. Nav. M. Bull. **44:** 1288–1291, June 1945.

The authors show plans for construction of a wet-film viewing room which had been found useful under conditions which do not permit extending the wash-water tank through the wall of the dark room. The viewing room is between 4 and 6 feet square and is provided with film illuminators, preferably wall-mounted. A light-proof pass tunnel below the level of the loading bench carries a wooden frame holding 6 films (14 × 17-in.). The frame slides on two wooden rails and is pulled manually from one room to the other. The light-tight lids of the pass tunnel are guarded by a simple sliding metal bar on top, so that when one lid is opened the other cannot be raised.

RADIOTHERAPY

NEOPLASTIC DISEASE

Adenofibrosis Mammae. The Norwegian Radium Hospital's Material 1932–1942. Rolf Bull Engelstad and Rolf Weyde. Acta radiol. **25:** 444–459, Nov. 21, 1944. (In English.)

During the ten-year period, 1932 through 1941, 142 patients, 3 men and 139 women, were treated at the Norwegian Radium Hospital for adenofibrosis mammae. Palpable alterations in the breasts, particularly in the upper outer quadrant, were found in 136 patients. In 54 cases, pain was the outstanding symptom, and in 2, the only symptom. A tumor was accidentally discovered by 54 patients and was the only symptom in 28. Tumor and spontaneous pains occurred together in 84 patients. Thirty-two patients had enlarged axillary nodes.

One hundred and twenty-three of the patients with adenofibrosis mammae were treated by roentgen rays. The mamma was irradiated tangentially from both sides, two fields on each breast. The field varied in size, usually being from 15 to 20 cm. in length. The technical factors were 180 kv., 4 ma., F.S.D. 50 cm., with a filtration of 0.5 mm. Cu. Each field was given a series of five treatments of 150–200 r, so that each breast received a total of 1,500–2,000 r in the course of ten to twenty days. Seventy-four of the 123 patients were symptom-free at the time of the report; 16 were relieved of pain but still had palpable mammary thickening; 6 were improved, with pain and palpable thickening; 27 were unchanged. Seventeen patients were subsequently operated upon.

Seven women bore children after the conclusion of the treatment. There was little or no milk secretion in 4 of these patients; lactation was abundant in 1, and in the other 2 cases no information is available.

On Improving the Results of Treatment in Cancer of the Collum of the Uterus. J. Heyman. Acta radiol. **25:** 551–563, Nov. 21, 1944. (In English.)

Heyman discusses a paper by Hultberg (Abst. in Radiology **45:** 643, 1945) which recommends hysterectomy on a larger scale in irradiated cases of cancer of the cervix, with a view to preventing local recur-

rences. Hultberg considers hysterectomy advisable because of the great number of local recurrences following irradiation, the presence of vital cancer tissue in specimens removed after radiotherapy, the results already obtained by the proposed intervention, and finally the impossibility of curing a local recurrence by repeating the intracavitary application of radium. Heyman is of the opinion that statements as to the percentage of local recurrences are unreliable and the presence of vital cancer tissue in specimens removed after irradiation of little importance. He believes that the number of patients lost at routine hysterectomy will probably exceed those saved by the operation. Results following radiotherapy in cervical cancer at the Radiumhemmet are submitted. These show that the five-year cure rate during the past seven years has increased considerably. Heyman believes that attempts to prevent local recurrences by improving the radiotherapeutic technic promise more than routine hysterectomy following irradiation.

Wilms' Tumors. Archie L. Dean. New York State J. Med. **45:** 1213–1217, June 1, 1945.

Various aspects of Wilms' tumors are discussed, using as a basis the reports of other workers in addition to experience with 80 cases seen at Memorial Hospital (New York).

In infancy Wilms' tumors are second in frequency only to tumors of the eye. They are congenital, embryonal, mixed tumors, arising from the kidney anlage. The average age of patients when the tumor has been discovered is about three years. The stage of embryonal development at which the tumors arise is of great clinical importance because this factor modifies the structure of the growth, its natural history, and to a considerable degree its response to different types of treatment.

Wilms' tumors grow rapidly and tend to metastasize fairly early, both by lymphatic extension and by way of the blood stream. Symptoms usually do not appear until late. If growth of the tumor is sufficient there may be vomiting, loss of weight, asthenia, anorexia, and the appearance on the abdomen of tortuous, dilated, superficial veins. Accidental discovery of a mass in the abdomen was the first finding in 64 per cent of the 80 cases seen at Memorial Hospital; pain in the loin or abdomen in 16 per cent; asthenia and malaise in 12 per cent; hematuria in 4 per cent; frequency of urination in 4 per cent. Fever is frequently present.

Discovery of a palpable tumor in the kidney region is the most important diagnostic sign and its presence in a young child should lead to a tentative diagnosis of Wilms' tumor. Other less frequent abdominal masses to be considered in differential diagnosis are lymphosarcoma or other tumors of the retroperitoneal or mesenteric lymph nodes, suprarenal tumors, tuberculosis of the kidneys, hydronephrosis, polycystic kidneys, tuberculous peritonitis, hepatic tumors, ovarian tumors, splenomegaly, pancreatic tumors, fecal tumors, and psoas abscess. Intravenous and retrograde urography and kidney function studies are recommended. Under no circumstances should the tumor be incised to obtain material for microscopic study, since this destroys the capsule and encourages rapid and widespread growth.

There is no clear-cut unqualified answer to the question, "What is the best treatment for Wilms' tumor?". Cure depends on removal or complete destruction of the neoplasm before metastasis occurs. Ladd's five-year survival rate of about 50 per cent in a series of cases treated by surgical removal alone (Am. Surg. **108:** 885, 1938) has not been approached by other surgeons. Of 20 patients treated at Memorial Hospital by irradiation alone, 5 are living, without evidence of disease, five or more years after treatment. The author does not, however, advocate this procedure. In cases without demonstrable metastases he recommends preoperative x-ray treatment, 100 r to one of three portals daily. Usually in about two weeks the mass is no longer palpable. The kidney is then promptly removed, with clamping and ligation of the renal pedicle before the tumor is disturbed. If any extension of the tumor is seen, postoperative irradiation is given, 100 r daily to one of four portals covering the side of the abdomen from which the tumor was removed. In cases with demonstrable metastases, irradiation alone is recommended for its palliative effect.

H. H. WRIGHT, M.D.

Multiple Carcinomas. A Case of Four Consecutive Primary Carcinomas with Apparent Cure. C. A. Holland. J. A. M. A. **128:** 356–359, June 2, 1945.

A case in which four metachronous primary cancers (adenocarcinoma of the right breast, squamous-cell carcinoma of the esophagus, basal-cell carcinoma of the left cheek, adenocarcinoma of the colon) occurred in the same person within a period of ten years is reported. Two of the lesions were treated by radical surgery and two by roentgen therapy, apparently with complete cure.

This is one of the first recorded cases of carcinoma of the esophagus with five-year cure following roentgen irradiation. Irradiation was administered (see communication, J. A. M. A. **128:** 1046, Aug. 4, 1945) over a thirty-eight day period in daily (occasionally the interval was forty-eight or seventy-two hours instead of twenty-four hours) doses of 100 r, to a total dose of 3,000 r, to each of four skin portals, anterior, posterior, and right and left oblique lateral. This heavy dosage was well tolerated, with a minimum of skin reaction and discomfort. Follow-up roentgenograms have shown the esophagus to be apparently normal.

Roentgen Treatment and the Course of Cure of Giant Cell Tumour in the Osseous System (10-12 Years' Cure). Gösta Jansson. Acta radiol. **25:** 569–579, Nov. 21, 1944. (In English.)

Four cases of giant-cell tumor of the osseous system which were treated by roentgen irradiation only, followed by ten to twelve years' cure, are recorded. The dosage which should be used in the treatment of such tumors is discussed. Pre- and post-treatment roentgenograms are reproduced.

Research with Radioactive Isotopes in the Treatment of Leukemia. Erik Lindgren. Acta radiol. **25:** 614–624, Nov. 21, 1944. (In German.)

The radioactive elements used in the research here described were sodium chloride containing $^{24}_{11}Na$ (half life, 15 hours) and Na_2HPO_4 containing $^{32}_{15}P$ (half life, just over 14 days). The radioactive sodium emits very hard gamma rays, while the phosphorus emits beta particles. It had been demonstrated that in normal

and leukemic experimental animals, radioactive phosphorus tends to localize in the lymph nodes, spleen, and liver. It should be possible, therefore, to use this element to give selective bombardment with beta particles to leukemic tissues. Similar selective absorption of $^{32}_{15}P$ by other neoplasms has also been demonstrated. The use of radioactive sodium was not based on metabolic selectivity, but on the idea of general body irradiation.

This report is based on 4 cases of myeloid leukemia, 1 of lymphatic leukemia, and 1 of polycythemia vera. Initially the radioactive salts were given intravenously and retention and excretion checked with a Geiger-Müller counter. The increased count was found to last as long as four but not five days after each injection. Later the phosphate solutions were administered by mouth in various media, of which glucose solution proved the best. The dose was 1.2 mc. in a week, later reduced to 0.8 mc. Patients showed a rather poor response to radioactive sodium, but the response to radioactive phosphorus was much better. Only palliation was obtained in all cases. Anemia did not occur as a result of this treatment, nor were there any side reactions. LEWIS G. JACOBS, M.D.

NON-NEOPLASTIC DISEASE

Roentgen Therapy for Acute Encephalitis. U. V. Portmann and Roger Lough. Am. J. Roentgenol. **53:** 597–602, June 1945.

The results of roentgen therapy in 49 cases of acute encephalitis are reported. The average skin dose was 75 to 100 r to each side of the head, including the base of the skull, given daily or on alternate days, usually for a total of 300 r or less. Usual 200-kv. technical factors were employed. Of the 49 patients, 29 recovered, 15 were improved, 1 died, and in 4 there was no follow-up. Best results were obtained when roentgen therapy was given before degenerative changes were established in the central nervous system. Relief of symptoms and signs was dramatic in many patients, improvement beginning within two to three days.

L. W. PAUL, M.D.

Roentgen-Ray Treatment of Tinea Capitis. Lester M. J. Freedman and Lawrence G. Beinhauer. Urol. & Cutan. Rev. **49:** 376–378, June 1945.

In a period of one year (1944–45), 53 patients with tinea capitis were treated with roentgen therapy: 41 males and 12 females, ranging in age from two to twelve years. Each patient was examined under filtered ultraviolet rays.

The basic principles of the Kienböck-Adamson technic were employed: that is, 5 circular fields 5 inches in diameter were used, centered over the vertex, frontal, occipital, and both supramastoid areas. The port centers of the neighboring fields were exactly 5 inches apart, and the central rays of adjacent portals were directed at right angles to each other. All areas were treated at one sitting, the factors being 100 kv.p., 10 ma., 25 cm. distance. Approximately 380 r per field was given. Epilation was uniform, beginning in seventeen to twenty-four days. It was complete in about a week in 47 cases. Incomplete epilation was obtained in 5 patients and in one there was no epilation. Regrowth of hair took place within ten to twelve weeks. Seven patients complained of headaches and nausea eight to twelve hours after therapy, but these symptoms rapidly disappeared. There was also some pruritus, and furunculosis and occipital adenitis occurred as a result of scratching.

MAURICE D. SACHS, M.D.

TECHNIC

Experiences with Roentgen Rotation Therapy. Lars Edling. Acta radiol. **25:** 427–443, Nov. 21, 1944. (In English.)

The apparatus for roentgen rotation therapy at the Gutavus V Jubilee Clinic in Lund is described, together with a discussion of the main principles of rotation therapy. A short report of the technical details of treatment, the dosage employed, and results obtained is included. A comprehensive bibliography on roentgen therapy with a movable beam is appended.

Condenser Ionization Chambers for Measurement of X-Rays in Body Cavities: Physical Problems in Their Design. F. T. Farmer. Brit. J. Radiol. **18:** 148–152, May 1945.

The construction of a small condenser ionization chamber is described. It is suitable for insertion into body cavities so that the depth dose can be measured directly. It has a capacity of 200 r with suitable accuracy for measurement during treatment.

SYDNEY J. HAWLEY, M.D.

A New Circuit with Special Applications in Gamma-Ray and X-Ray Dosimetry. L. A. W. Kemp. Brit. J. Radiol. **18:** 107–112, April 1945.

A simple circuit by which two ionization currents may be compared is described. This was designed primarily for measuring radon seed strengths, and its use for this purpose is described in detail. It may be used for measuring x-ray beams also. It can be calibrated to read directly in r.

SYDNEY J. HAWLEY, M.D.

Defects in Roentgen Tubes Demonstrated by Gamma-Ray Photographs. Sven Benner. Acta radiol. **25:** 414–417, Nov. 21, 1944. (In German.)

In a number of x-ray therapy tubes the output decreased for no apparent reason. Attempts to radiograph the target with x-rays (165 kv.) were unsuccessful because of diffuse fog, but gamma-ray photographs of satisfactory quality were obtained by using a 50-mg. radium tube with 0.35 mm. gold and 0.30 mm. platinum filtration. At a radium-film distance of 70 cm. an exposure of four to five hours was required with intensifying screens, or about thirty hours without screens. These films showed that the tungsten button had worked loose from the copper stem in several instances. LEWIS G. JACOBS, M.D.

A Technique for Auto-Radiographs of Radium Containers. Dorothy F. Clephan. Brit. J. Radiol. **18:** 117–120, April 1945.

A method is described for checking the distribution of radium in tubes and other containers, by autoradiography. The radium containers are placed on a tray made of clear film in which have been cut grooves to keep the needle or tube from rolling or sliding. Identification of the container may be made by placing lead numbers and letters beside it on the tray. The tray is

then placed in contact with an x-ray film. A flash exposure is made with ordinary light to outline the container and its label, and the container is then allowed to make its own exposure on the film. A formula is given for determining the exposure. All radium containers should be examined in this manner every five to ten years. SYDNEY J. HAWLEY, M.D.

EFFECTS OF RADIATION

Implications from Studies with Physical Carcinogens. Paul S. Henshaw. J. Nat. Cancer Inst. **5:** 419–436, June 1945.

The practical effects and the theoretic effects which produce a state from which cancer is generated are set forth in this article. The paper "(1) brings together pertinent information derived from studies with physical carcinogens; (2) considers the broad implications arising therefrom; (3) seeks to correlate the findings of similar results obtained with other carcinogens; (4) examines this body of evidence in the light of various ideas of cancer; and (5) sets forth the writer's view of carcinogenesis at this time."

The more significant physical carcinogens are listed as mechanical irritation, heat, sunlight, ultraviolet light, and ionizing radiations. Under this last heading the author considers radiocarcinoma, radiosarcoma, and radioleukemia.

Radiocarcinoma was of more frequent occurrence in the early days of roentgen therapy, when the effects of irradiation with x-rays were not appreciated. Radiosarcoma is well illustrated by the radium watch-dial cases, in which the ingestion of radium was followed by the occurrence of bone sarcoma (Martland: Am. J. Cancer **15:** 2435, 1931). Radioleukemia is believed to have a higher incidence among radiologists than any other group. The role of radiation in leukemia has also been shown experimentally, an incidence of 3.5 per 1,000 being observed in irradiated mice as compared with 0.6 per 1,000 in non-irradiated mice (Krebs, Rask-Nielsen, and Wagner: Acta radiol. Supp. 10, 1930).

The combined action of physical and chemical carcinogens has been found to be the quickest and surest way to produce skin cancer in animals.

The remainder of the article gets away from the recording of findings in the literature and discusses current theories on carcinogenesis under the following headings: (1) findings with carcinogens other than physical; (2) similarity of embryonic differentiation and carcinogenesis; (3) views regarding the underlying cancer process; (4) cancer as a form of differentiation; (5) general views, under which heading the author puts forth his views on carcinogenesis and nicely integrates the time-honored triad of (*a*) something coming into the cell from outside, (*b*) changes in certain of the inherent constitutional elements of the cell, (*c*) a process of development.

This article clearly shows long association with a subject to which no solution is apparent at the present time. S. F. THOMAS, M.D.

EXPERIMENTAL STUDIES

Mechanism of Shock from Burns and Trauma Traced with Radiosodium. Charles L. Fox, Jr., and Albert S. Keston. Surg., Gynec. & Obst. **80:** 561–567, June 1945.

In studies of shock, emphasis has recently shifted from the plasma proteins and other colloids to the electrolytes. Clinical studies in shock caused by extensive thermal burns have demonstrated the therapeutic efficacy of large doses of sodium salts in isotonic solution and led to the discovery of an unexpectedly large sodium retention. These studies suggested that redistribution of sodium was possibly a fundamental derangement in shock and prompted experimental studies with radiosodium.

Two types of experiments were conducted in mice subjected to standardized shock from burns and trauma. In one type the animals were given radiosodium in isotonic sodium chloride. Shock was produced twenty hours later, and the concentration of radiosodium in the tissues and organs was determined. In a second type of experiment shock was produced first, and the animals were then treated with radiosodium in isotonic saline. Twenty hours later, upon recovery from potentially fatal shock, the radiosodium content was determined in tissues and organs.

The sodium content of injured skin and muscle was found to be greatly increased and to exceed the gain in water (edema). This indicated that additional sodium accumulated in the intracellular compartment.

As a result of redistribution of sodium and water, approximately one-half the total amount of extracellular sodium was side-tracked and rendered unavailable. Administration of this amount of sodium by injection of 0.9 per cent sodium chloride containing radiosodium was followed by nearly complete retention of sodium in the injured mice but by excretion of sodium in normal animals. The hypothesis that loss of plasma proteins at the site of injury is the most important factor in the production of shock appears to be incorrect. The volume of circulating plasma is believed to be largely dependent upon the volume of extracellular fluid and its concentration of sodium. The side-tracking of sodium in injured tissue thus causes a reduction in plasma volume. C. R. PERRYMAN, M.D.

Resistance to Tumour Grafts Produced by a Cell-Free Tumour Extract. S. Russ and G. M. Scott. Brit. J. Radiol. **18:** 173–175, June 1945.

A cell-free extract of Jensen's rat sarcoma was obtained by squeezing the tumor. When this fluid was injected into other animals, which were subsequently inoculated with small tumor grafts of the same type, various results ensued, depending upon the state of the tumor from which the extract was obtained. If the growth from which the extract was expressed was rapidly growing, the growth of tumors in the recipient animal was stimulated. If the extract was from a tumor regressing either spontaneously or as the result of irradiation, regression occurred in the tumors in the recipient. Many of the animals receiving this type of extract were totally immune to the sarcoma. If the extract was from an irradiated tumor which had not begun to shrink, no effect, either stimulation or inhibition, was seen. SYDNEY J. HAWLEY, M.D.

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